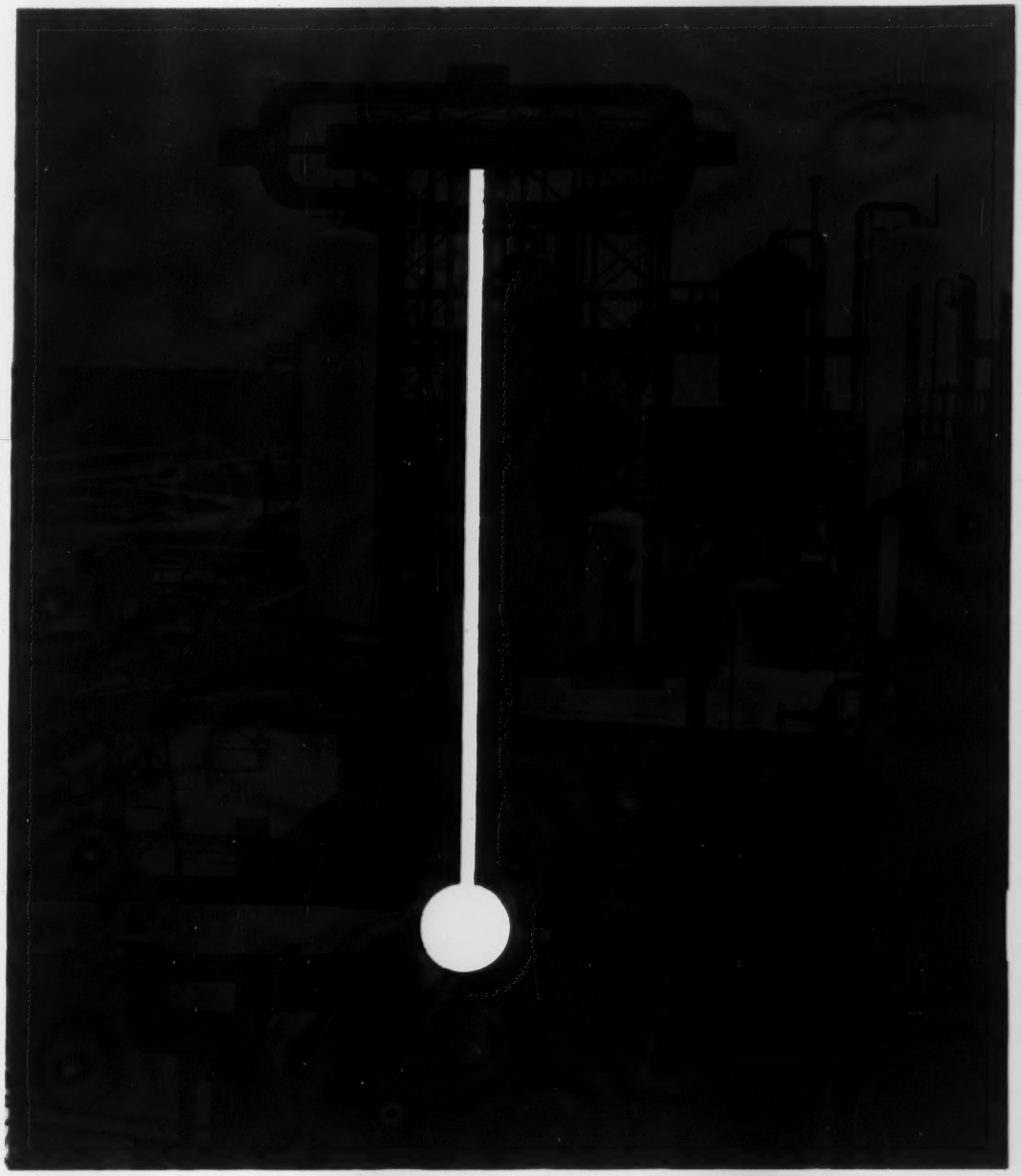
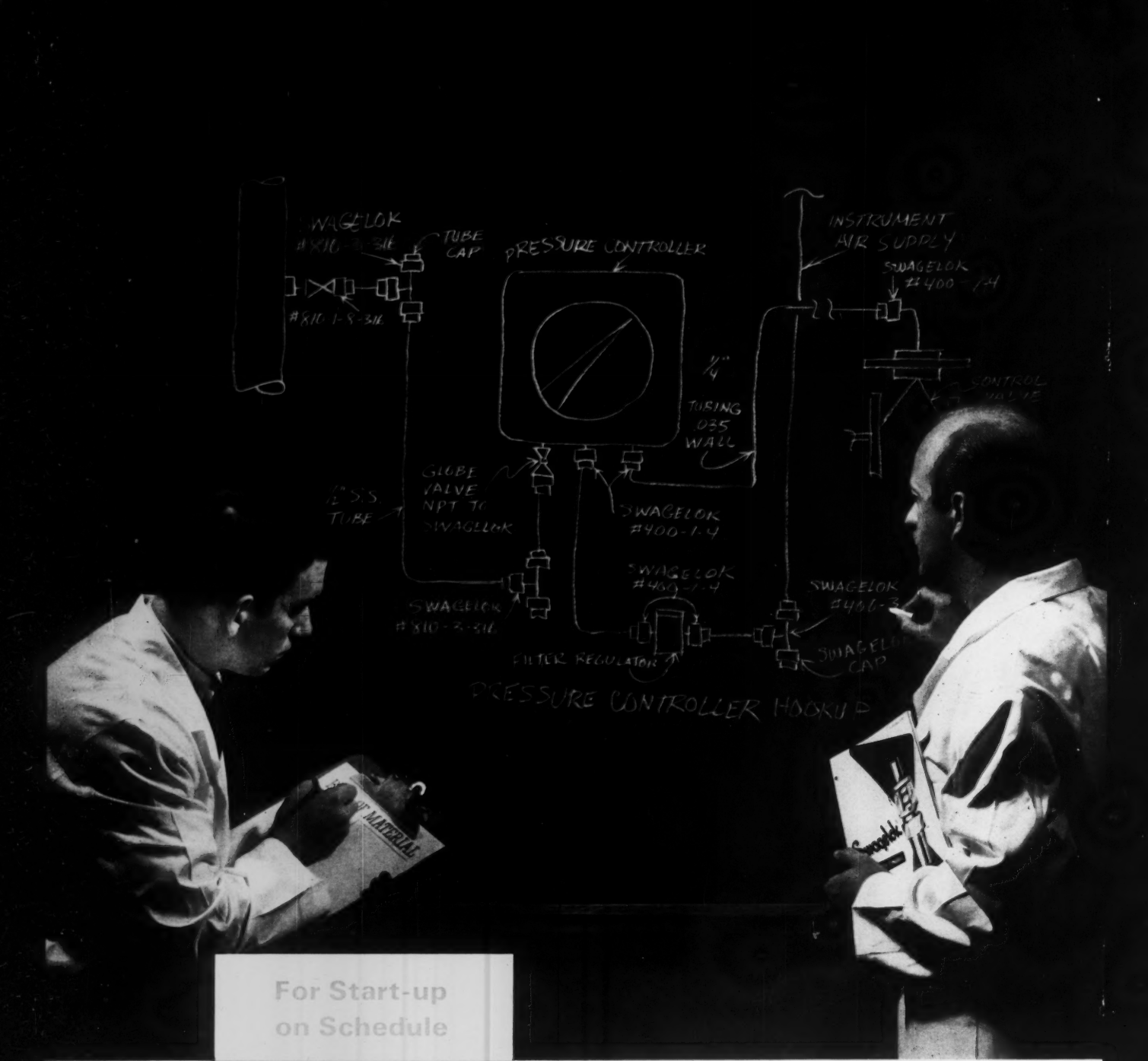
INSTRUMENTS AND CONTROL SYSTEMS

OCTOBER 1961 INCLUDING: JOURNAL OF THE SCMA • PRECISION MEASUREMENTS ASSOCIATION • SIMULATION COUNCIL NEWSLETTER



PART 1

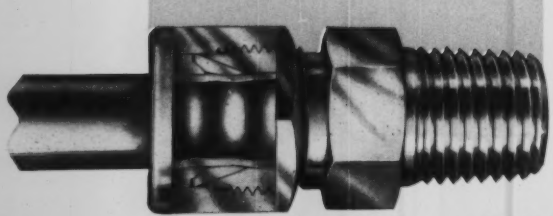
Ball Valves 1845
High-Power Valve Actuators 1851
Resistance Thermometers Above 2200°R 1864
Dimensionless Strain Gages 1870
Variable-Reluctance Transducers 1876
Electronic Timing 1883
Part 2—Annual Buyers' Guide (separately bound)



For Start-up
on Schedule

Specify

Swagelok®



Don't Let Leaky Connections Cause Expensive Delay at Start-up

These engineers are specifying Swagelok for plant construction. The most severe test of tube fitting design and quality is in plant construction. Many plants have been built using 10,000 to 20,000 or more Swagelok tube connections without a leak. You can spend days to find one leak among the thousands of tube connections on a construction job.

Insure plant start-up on schedule—specify Swagelok

CRAWFORD FITTING COMPANY, 884 East 140th St., Cleveland 10, Ohio
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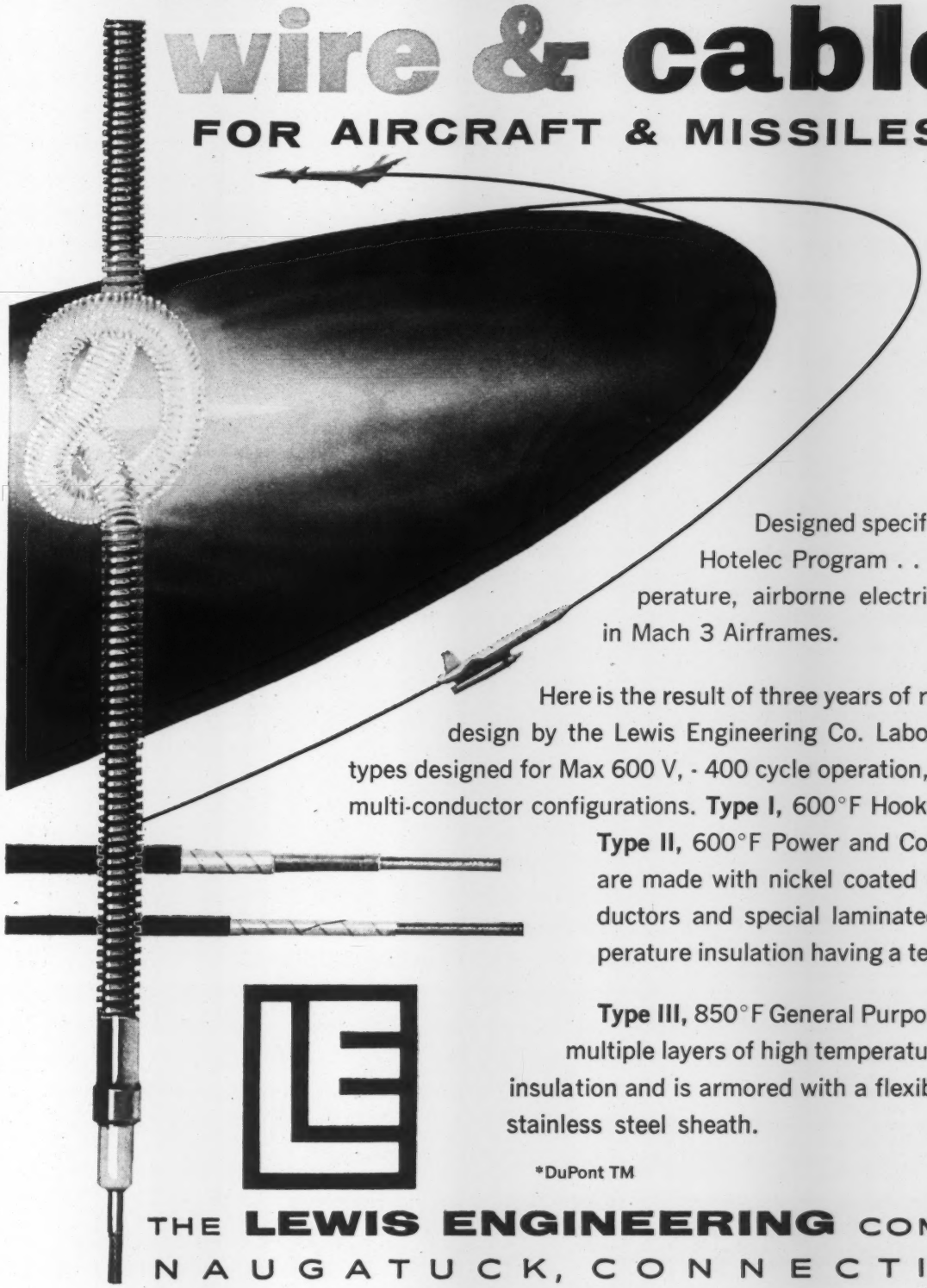
CIRCLE 1 ON READER-SERVICE CARD

HIGH TEMPERATURE

insulated wire & cable

FOR AIRCRAFT & MISSILES



Designed specifically for the Hotelec Program . . . High Temperature, airborne electrical systems in Mach 3 Airframes.

Here is the result of three years of research and design by the Lewis Engineering Co. Laboratories: all types designed for Max 600 V, - 400 cycle operation, in single or multi-conductor configurations. **Type I,** 600°F Hookup wire and **Type II,** 600°F Power and Control cables are made with nickel coated copper conductors and special laminated high temperature insulation having a teflon* finish.

Type III, 850°F General Purpose cable has multiple layers of high temperature inorganic insulation and is armored with a flexible monel or stainless steel sheath.

*DuPont TM

THE **LEWIS ENGINEERING** COMPANY

NAUGATUCK, CONNECTICUT

CIRCLE 2 ON READER-SERVICE CARD

SENSITIVE RESEARCH

A NEW AC VOLTAGE STANDARD

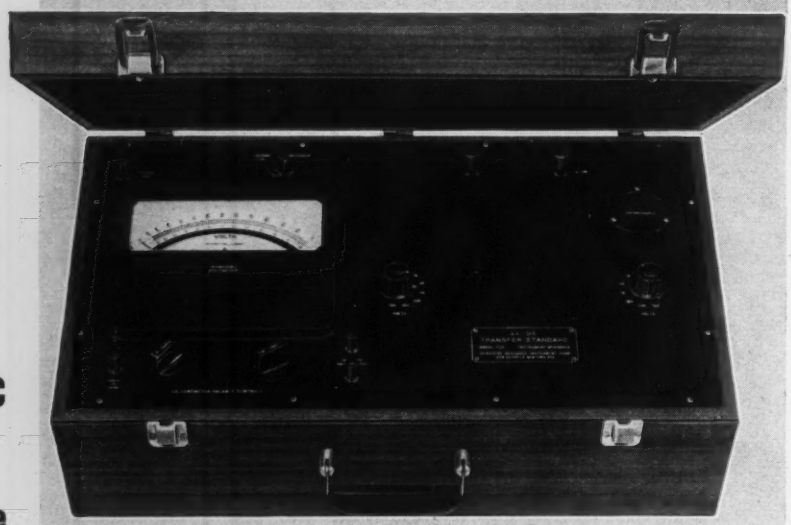
■ .01%* Accurate AC/DC Difference Measurements

■ .013% Accurate Absolute AC Voltage Measurements

■ Full Accuracy Over Entire Frequency Range from 20 cps—50,000 cps

■ True RMS Response

The Model FLH has been named in honor of Francis L. Hermach of the National Bureau of Standards in Washington, D. C., in recognition of his accomplishments in the field of AC/DC transfer measurements.



MODEL FLH

FREQUENCY CORRECTIONS IN % OF READING MODEL FLH

VOLTS	20 Kc	30 Kc	50 Kc
1.5-4.5	0	0	+.01
above 4.5-11.25	0	0	0
above 11.25-22.5	0	0	0
above 22.5-45	0	0	—.012
above 45-112.5	0	0	—.015
above 112.5-225	0	0	0
above 225-450	0	0	—.026
above 450-1125	—.027	—.038	—.069

**It is the present policy of NBS to state their maximum measuring uncertainty as ±.02%. However, they are expected to reduce this possible error to ±.01% in the near future, and the instrument is guaranteed on this basis. It is also their present practice to limit testing to 30 kc on instruments of the Model FLH's accuracy unless the user is in a position to justify that certification to 50 kc or higher is imperative. Correspondence between NBS and the user is required in such an instance.*

The Model FLH is a *NEW* thermocouple transfer standard designed to measure directly in percentage of reading, the influence of frequencies between 20 cps — 50,000 cps on the indication of voltmeters, calibrators, and other transfer standards over a range of 1.5 — 1125 v. It is supplied with an NBS Certificate* showing correction figures for those values of voltage where the AC/DC difference (or frequency influence) is, or exceeds, ±.01%. Typical performance characteristics are listed in the table on the left. These figures illustrate that it is seldom necessary to apply corrections to achieve substantially better performance than is basically guaranteed. Since the highest volt ranges have the greatest frequency influence, in practical usage the lower volt ranges can be considered to have either greater fundamental accuracy or a frequency span well beyond 50 kc.

The Model FLH when employed in conjunction with precision DC potentiometers and their accessories, is ideally suited for use in the certification of other AC voltage standards and the making of extraordinarily high accuracy absolute AC measurements. **An AC system accuracy of ±.013% can be obtained without difficulty** by combining the FLH with Sensitive Research "COMMANDER" Instruments such as the Dauphinee DC Potentiometer, Type 9144 (accuracy ±.001%), the NBS Volt Ratio Box, Type 9700A (accuracy ±.001%) and Saturated Standard Cells, Type 4305 and Constant Temperature Enclosure, Type 9152 (accuracy ±.001%). A "COMMANDER" Instrument Catalog is available upon request.

The basic accuracy of the Model FLH is derived from the flat frequency response of its multipliers. Long term resistor stability is of no importance. If the instrument is not physically impaired its frequency response will remain fixed indefinitely.

Replacement thermocouples are of the uncalibrated type.

ADDITIONAL SPECIFICATIONS

Accuracy using NBS correction figures: ±.01% of reading from 20 cps — 50 kc.*
Accuracy without using correction figures: ±.01% of reading to 30 kc from 1.5—450 v; ±.03% to 50 kc; ±.05% of reading to 30 kc from 450—1125 v; ±.075% to 50 kc.
Resolution: ..... ±.005% minimum.
Price: ..... $1685.00 (includes NBS Certificate and Type SR4 Galvanometer).
Terms: ..... Net 30 days, f.o.b. NBS, Washington, D. C.

Write for additional information or contact your nearest SRIC sales representative.

Symbol of Quality

SENSITIVE RESEARCH INSTRUMENT CORPORATION
NEW ROCHELLE, N. Y.

ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

CIRCLE 3 ON READER-SERVICE CARD

INSTRUMENTS AND CONTROL SYSTEMS

A valve emphasizes the subject of major discussion this month—process instrumentation

PART I, VOLUME 34, NUMBER 10, OCTOBER 1961

PRINT ORDER THIS MONTH 45,200

EDITORIAL

1961 ISA Show 1843

FEATURE ARTICLES

Ball Valves 1845

FRED MARTON—A survey of types and sizes available

High-Power Valve Actuators 1851

J. C. BOONSHAFT—Combination electric, pneumatic and hydraulic techniques are used for high power and fast response

Heatless Reactivation of Desiccant Dryers 1855

E. M. FEELEY and E. J. KUNNAS—The dry air itself can be used to dry the desiccant in a dryer

Journal of The Southern California Meter Association 1859

HYDRAULIC VALVE ACTUATORS SAVE HALF-MILLION DOLLARS by G. G. GALLAGHER, C. L. GRIESBAUM and R. D. FOSTER—One third of the cost of instrumentation for a plant was saved by use of hydraulic valve actuation

Ceramic Resistance Thermometers as Temperature Sensors Above 2200°R 1864

A. R. ANDERSON and T. M. STICKNEY—Vitrified ceramics can be used as resistance thermometers above 2200°R

The "Dimensionless" Strain-Gage Transducer 1870

C. E. MATHEWSON—New design reduces the stability problems of conventional gage configurations

Journal of the Precision Measurements Association 1873

HIGH-SPEED THREE-COLOR PYROMETER 1873
THERMOCOUPLES FOR HIGH TEMPERATURES 1874
JAMES A. BARD
MEASUREMENT OF HYPERSONIC FLOW 1874

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INSTRUMENTS AND CONTROL SYSTEMS VOL. 34 NO. 10 OCTOBER 1961

Variable-Reluctance Pressure Transducers 1876

SAUL EPSTEIN—Variable-reluctance transducers feature good response and high output

Process Control Systems 1878

Hydraulic power supply regulation to 1.5% with pressure switch and damping network

Electronic Timing 1879

R. F. LANDER—Precise timekeeping and synchronization of remote equipments demands electronic timing techniques

SIMULATION COUNCIL NEWSLETTER 1883

Midwestern S/C Meeting of 15 May on Education 1883

Rocky Mountain S/C Meeting of 27 June on Turbine Engines, Static and Frictional Forces and True Inputs 1888

Analog Techniques—Pulse Circuit by Tom Anderson 1889

PART TWO

The annual *Instruments and Control Systems Buyer's Guide*, listing the products of over 2500 manufacturers of instruments, controls, components, and accessories, is the companion volume to this October issue.

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New Instruments 1894
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New Literature 1954
Advertisers' Index 1958
Searchlight Section 1960

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INSTRUMENTS AND CONTROL SYSTEMS; INSTRUMENT & APPARATUS NEWS; MILITARY SYSTEMS DESIGN; MEDICAL ELECTRONIC NEWS

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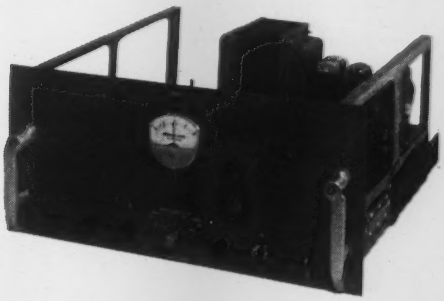
London, W. C. 2 England, John C. N. Hughes, T. C. Scott & Son Ltd., No. 1 Clement's Inn, Holborn 4743.

Data loss due to drop-outs is eliminated in FM predetection recording-reproducing by Mincom's new, exclusive Tracklok®

This is because, for the first time in the field of instrumentation, the **Tracklok** makes possible redundant FM data recording at the carrier level. In any desired FM or PM-type carrier system, data loss is eliminated by a 99% skew reduction; existing skew of ± 0.3 μs for example, is effectively reduced to ± 0.003 μs, a reduction of 100 to 1.

Shown here with the Mincom Series CM-100 1.5-mc Instrumentation Recorder/Reproducer, a standard auxiliary rack houses (from the top down) an oscilloscope monitor unit, the new **Tracklok**, and a demodulator.



The Tracklok

Completely Compatible: The new **Tracklok** is designed to improve the predetection performance of Mincom's 1-mc Series CM-100 Instrumentation Recorder/Reproducer (which now, on special order, performs to 1.5 mc at 120 ips). **Tracklok** can be incorporated into all existing Series CM-100 systems, since it is compatible with CM-100 or any comparable recorder-reproducer in the standard IF carrier frequencies.

TRACKLOK®

Reliable Simplicity: The same reliability that has been typical of Mincom's instrumentation systems for years has been built into **Tracklok.**

MINCOM DIVISION **3M** **MINNESOTA MINING & MANUFACTURING CO.**

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CIRCLE 4 ON READER-SERVICE CARD

FOR QUALITY... PRODUCTIVITY ...PROFIT

INSTRUMENTATION FOR AUTOMATION

PROBLEM: how to collect, record and transmit critical fluid flow data more *accurately* than ever before.

SOLUTION: custom-designed flow measurement systems from General Electric.

RESULT: reliable process control, simplified fluid accounting, precision batch blending and loading.

System instrumentation includes: true mass flowmeter, available in 13 standard ranges ■ null balance recorders, a full line of strip and round-chart ■ new telemetering equipment, analog and digital.

In addition, ticket printers and totalizing counters are available for visual digital display and pre-set counters may be added to provide precision control in blending and loading operations.

FOR FLUID FLOW PROCESS:

In a variety of system applications, these General Electric instruments cut operating costs and boost plant production . . . through *simplified* and *more accurate* measurement. No wonder they've been specified by process engineers throughout the world. *Performance-proved . . . on the line!*

For complete information, contact your nearby General Electric sales office or write Section 599-08, General Electric Co., Schenectady 5, N. Y. for the following bulletins: GEA-6925, Mass Flowmeter; GEA-6887, Null Balance Recorders; GEA-7163, Telemetering Systems. In Canada, contact Canadian G.E. Co. Ltd., 940 Lansdowne Ave., Toronto 4, Ontario. Outside the U.S. and Canada, contact International G.E. Co., 150 E. 42nd St., New York 14, N. Y.

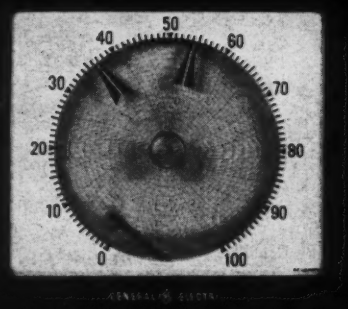
INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

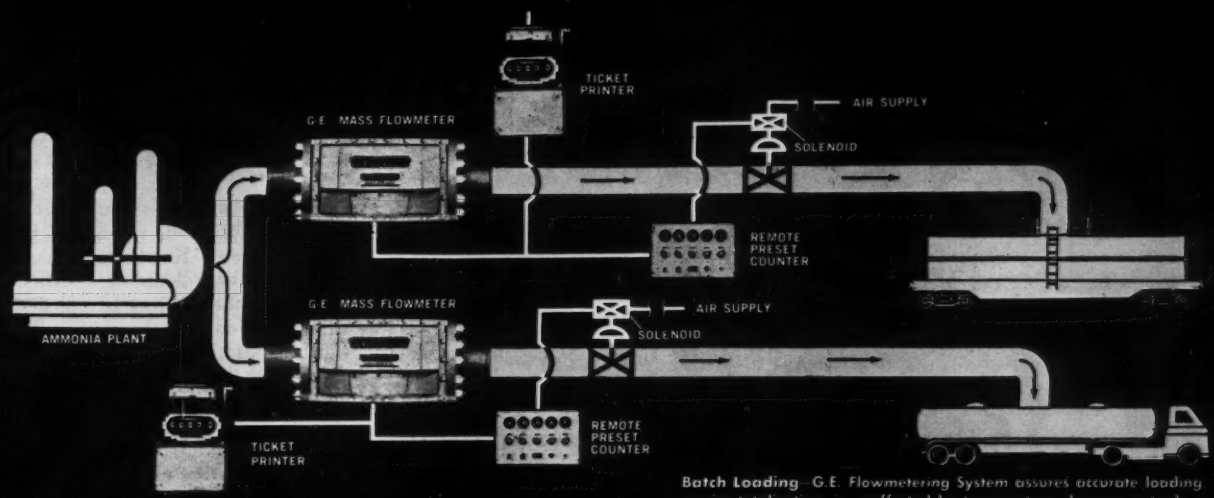
CIRCLE 5 ON READER-SERVICE CARD

Mass Flowmeter measures fluid flow directly in pounds, eliminates volume-to-mass conversion. ±1% accuracy unaffected by change in pressure, density, temperature, viscosity, flow rate. 13 standard ranges now available.

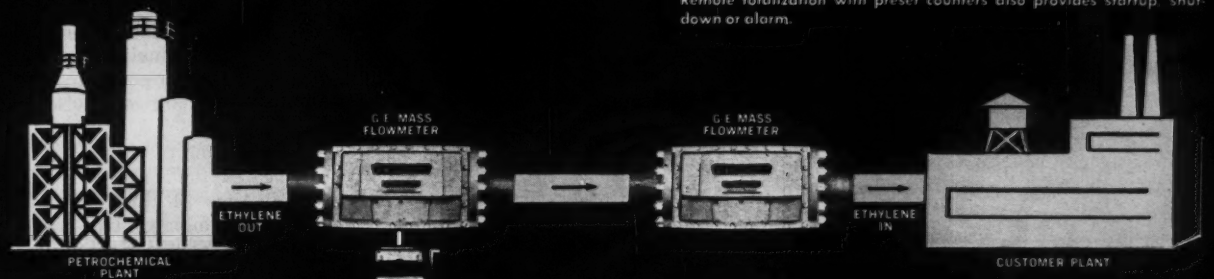
HIGH ACCURACY



General Electric Null Balance Recorders feature: silicon diode reference voltage source for operational reliability; varied control forms for versatile applications; components mounted on swing-out panel to simplify routine maintenance. Full line includes multipoint, single and two-pen—strip or round-chart models.

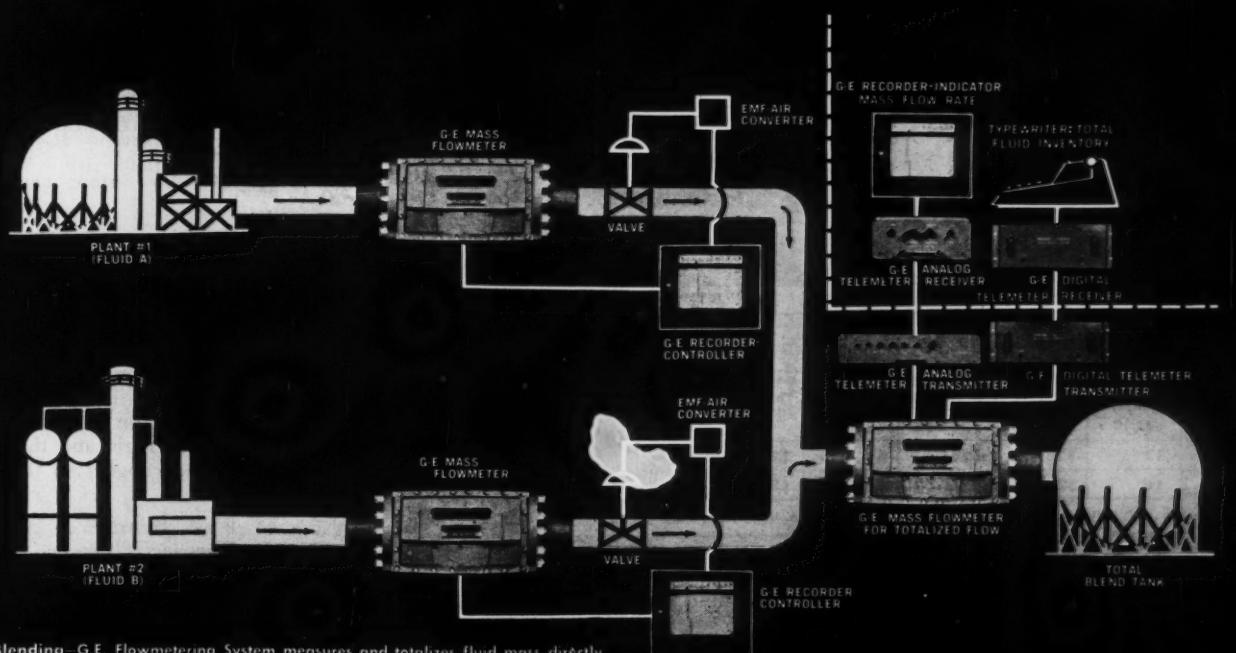


Batch Loading—G.E. Flowmetering System assures accurate loading, precise totalization; is unaffected by temperature changes in tank or pipe. Meter measures different fluids with no calibration change. Remote totalization with preset counters also provides startup, shut-down or alarm.



Custody Transfer—G.E. Flowmetering System assures accurate measurement at both ends of transfer despite differences in operating conditions. Ticket Printer provides printed record of fluid shipped. System offers simplified, accurate accounting between producer and customer plants and also in interplant transfers.

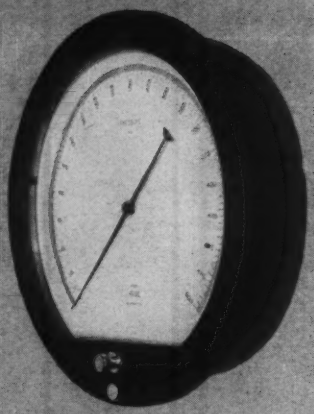
MEASUREMENT SYSTEMS FROM GENERAL ELECTRIC



Fluid Blending—G.E. Flowmetering System measures and totalizes fluid mass directly, eliminates laborious volume-to-mass conversions. Predetermining counters assure simplicity and accuracy in blending operations. Data is instantly telemetered to central locations by new G-E Telemetering. Typical blends are refrigerants, solvents and special naphthas.

HEISE GAUGES

Test Standard ACCURACY



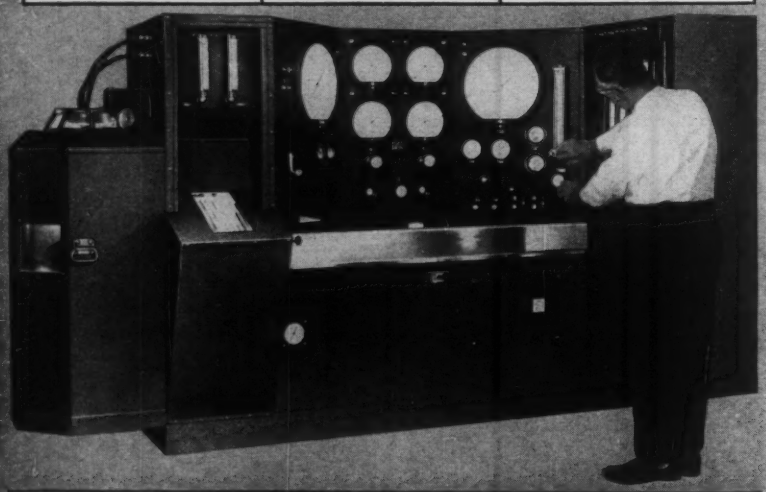
Only Heise gauge guarantees accuracy to 0.1 of 1% full scale reading at all points on a fully graduated 270° dial.

In laboratories throughout the world, the Heise gauge is being used as a test reference for recalibration of other instruments and testing of critical components.

All Heise gauges maintain the same standard of accuracy and are available in ranges from 0 to 15 p.s.i. to 0 to 100,000 p.s.i. Hysteresis, regardless of pressure range, is held within the same 0.1 of 1%.

The Heise laboratories, specialists in Bourdon tube equipment since 1930, have developed and perfected this instrument which stands alone in the field as a secondary standard approached only by the primary dead weight tester.

ACCURACY	HYSTERESIS	CAPACITY
0.1 of 1%	0.1 of 1%	0-100,000 p.s.i.



Dial Sizes	FULL SCALE READING (P.S.I.)						
	0-15 to 0-5,000 inclusive	Over 0-5,000 and including 0-20,000	Over 0-20,000 and including 0-30,000	0 to 40,000	0 to 50,000	0 to 75,000	0 to 100,000
8½"	$183.50	$205.50	$238.50				
12"	$209.50	$231.50	$264.50	$275.50	$286.50	$336.50	$386.50
16"	$255.50	$277.50	$310.50	$321.50	$332.50	$382.50	$432.50

DELIVERY — 2 WEEKS FOR MOST RANGES — PRICE F.O.B. NEWTOWN

Request Catalog for SPECIAL FEATURES

HEISE BOURDON TUBE COMPANY, INC.

BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

CIRCLE 6 ON READER-SERVICE CARD

I&CS LETTERS TO THE EDITOR

Editor, I&CS:

In the August issue of your magazine we notice an article on Remote Utility Meter Reading, transmitting the data over telephone systems. This has been the subject of considerable investigation by others as well as the authors of this article. However, the system as discussed in this article and as proposed by others, to use telephone lines for data transmission, has in our opinion, three fatal defects:

1. Not all meters can be connected to telephone lines. This means that meter readers cannot be eliminated by any system of telephone transmission data. The meter readers would have to make their present rounds, reading a portion of the meters that could not otherwise be connected.

2. A system of this sort is very complicated.

3. Systems of this sort are completely uneconomic. The cost of installing the system, including rental charges for telephone rented data, are substantially beyond the cost of reading meters manually.

A more realistic approach to the problem is provided by the Teleread unit described in the enclosed literature. This does not pretend to replace the meter reader because no system has been devised which can do this. It does make the meter twice to three times more efficient than at present, and achieves the other benefits described in the literature.

H. F. Barrett, Gen. Sls. Mgr.
Buffalo Meter Co., Inc.
Buffalo 14, *N. Y.*

See page 1800 for details on the Teleread.

Editor, I&CS:

I have received my first copy (July issue) of I&CS. In the article entitled "Magnetic Core Logic" reference was made to previous articles on logic functions. Will you please send me a list of these previous articles on transistor logic and the issues in which they appear so that I can order them.

W. E. Winston
Electrical Foreman
Plantation Pipe Line Co.
Baton Rouge, La.

Welcome aboard—but we are sorry that you missed the symbolic-logic

articles that preceded your subscription to I&CS. Several issues are sold out completely; you will have to refer to a library. Here are the articles:

- Boolean Algebra by Wires, February, 1960
- Digital Systems by Symbolic Logic, Brooks, March, 1960
- Addition and Subtraction by Symbolic Logic, Brooks, April, 1960
- Serial Comparison by Symbolic Logic, Brooks, May, 1960
- Ring Codes by Symbolic Logic, Brooks, June, 1960
- Manipulation of Symbolic Logic Expressions, Lytel, July, 1960
- Gray-To-Binary Conversion by Symbolic Logic, Brooks, August, 1960
- Decade Counting, Bukstein, August, 1960
- NOR Logic, Boswell, September, 1960
- Dividing Pulse Trains by Symbolic Logic, Horton, October, 1960
- Function Generation with a DDA, Silber, November, 1960
- Bidirectional Counting, Hupp, December, 1960
- Digital Comparison by NOR Logic, Boswell, January, 1961
- Code Conversion by NOR Logic, Boswell, February, 1961
- Pulse Analysis by Histogram with Logic Matrix, Caggiano, March, 1961
- Shift Register Logic, Brooks, April, 1961
- NOR Addition, Crozier, May, 1961
- Data-Bloc Symbolic Logic, Engman, June, 1961
- Magnetic Core Logic, Kodis, July, 1961
- Logical Design of Control Systems, Sept., 1961

This series soon will be made available in book form.

Editor, I&CS:

We have a new cardiopulmonary fitness testing laboratory and shall be using exercise stressors, collecting and analyzing expired air, strength testing, and assessing bone and adipose tissue. I am particularly interested in contacting firms which produce (1) analytical mass spectrometers, (2) anthoropometrical instruments (fat calipers, goniometers, tapes, etc.), (3) dynamometers, and (4) valves, solenoids, tubing flow meters, etc., for expired air collection and measurement to mention a few things.

Joseph A. Mastropaolo, Ph.D.
Research Fellow,
Cardiopulmonary Fitness Testing Laboratory,
Board of Health
Chicago 10, Illinois

Editor, I&CS:

Your trial (separating articles so they can be removed) was wonderful —not a conflict in the issue! Thanks!

Erik Wiik
Ponca City, Okla.

3 lb. to 90 tons an hour. That's the span of Merchen Feeder capacity. 1% of set rate and 1000:1. That's its accuracy and range. Coal, pigments, wheat, carbon, sawdust. These are some of the 175 common, dry, free-flowing materials a Merchen feeds with ease.

These figures tell the story of a Merchen's versatility. Whether you blend continuously or by batch, the Wallace & Tiernan Merchen Feeder simplifies your entire process. Use it as a straight gravimetric feeder, as a master proportioning other ingredients in the process, or as a slave with instant response to external pneumatic signals.

The Merchen responds to a change of just one ounce in a 63-pound belt load. That's because the Merchen weighs only actual material—never feeder components. This means constant delivery with minute-to-minute accuracy of ±1%. Corrosion-resistant construction means long, trouble-free life. And the Merchen's compact size—less than 3 ft. x 5 ft. for the largest model—lets it fit almost anywhere.

Information from Dept. M-60.48.

WALLACE & TIERNAN INC.
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

CIRCLE 7 ON READER-SERVICE CARD

NEW BARTON 273 PNEUMATIC TRANSMITTER MEETS MORE APPLICATION REQUIREMENTS THAN ANY OTHER TRANSMITTER

The Barton 273 offers the widest differential pressure ranges (0-8" w.c. to 0-400 psi), the highest safe working pressures (to 10,000 psi), and the widest variety of housing materials (aluminum, brass, steel, 316 stainless steel). It's compact, weighing up to less than ½ the weight of other units. It has adjustable suppression up to 80% of DP range, and adjustable span. A non-bleed relay minimizes air consumption. It doesn't shift zero on overrange. It's unaffected by normal piping stress. In every respect, the Barton 273 is the most significant advance in pneumatic transmitters in the past decade. There's a lot more you should know about it—for complete data write

BARTON

INSTRUMENT CORPORATION, 580 MONTEREY PASS ROAD, MONTEREY PARK, CALIFORNIA.

CIRCLE 8 ON READER-SERVICE CARD

Editor, I&CS:

Thanks! 14 pages removed for separate filing and not one conflict! Usually I have to make a choice, or put an entry in a file to look elsewhere!

You have proved a point—now to work on some of the other mags!

Edward W. Logan, Jr.
Memphis 12, Tenn.

Editor, I&CS:

Information is requested in regards to the date of issue and title of the previous articles published in the "ICS Memory Series," as we note No. 8—Magnetic Memory Cores, appeared in the August 1961 issue.

Eugene F. Stein
Radar Engineering
The Magnavox Company
Fort Wayne 4, Indiana

Here they are:

1. Computer Storage Techniques—Oliver, December, 1961
2. Permanent Storage Media—Constant, February 1961
3. Thin-Film Memories—Bittman, March, 1961
4. Drum and Disc Storage—Gottschalk and Wayslenko, April, 1961
5. Fluxlok High-Speed Core Memory—Tillman, May, 1961
6. Flexible-Disc Storage—Pearson, June, 1961
7. Twistor Memories—McCabe, July, 1961
8. Magnetic Memory Cores—Whitmer, August, 1961
9. Delay Line Memories—Ellis, September, 1961

Other articles are in preparation. A complete survey of drum and disc memories will appear in Jan., 1962

Editor, I&CS:

With respect to Reader Inquiries on page 973 of June, 1961, titled M-16 on blood urea nitrogen, I recommend that the method of Fearon, *Biochemical Journal*, vol. 33, page 209, 1939, as modified by Friedman in the *Analytic Chemistry*, vol. 25, page 662, 1953, be tried, and recommend further that Beckman Spinco Systems have devised an ultramicro technique requiring 10 microliter of serum for a color metric determination based on diacetyl monoxine and arsenic color determinations.

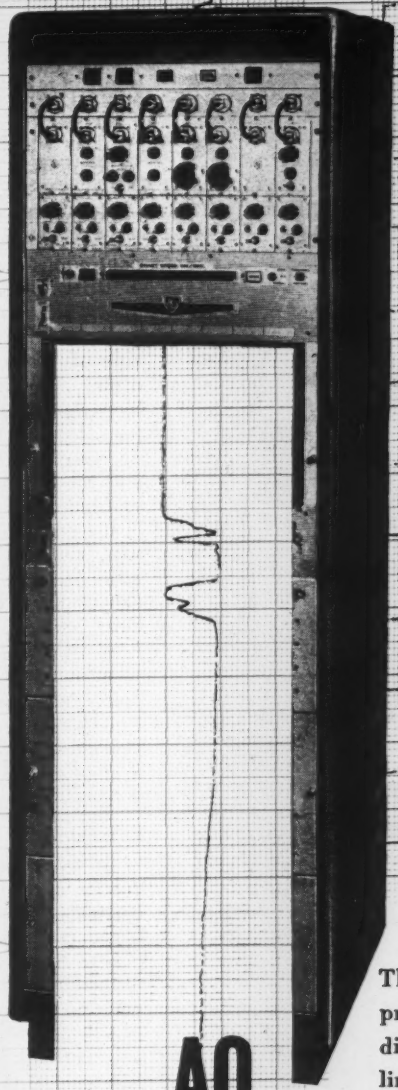
H. William Gillen, M.D.
Attending Neurologist
Edward J. Meyer Memorial Hospital
Buffalo 15, N. Y.

Editor, I&CS:

With regard to M-39 of your "Help the Medical Field" section, we feel that we can be of help.

John V. Hogan
Hogan Faximile Corporation
Subsidiary of TELautograph Corp.
New York 14, N. Y.

CIRCLE 9 ON READER-SERVICE CARD →



AO Trace-master provides twice the definition

The unique direct-carbon-transfer writing method produces a trace from 2 to 3 times finer than any other direct-writing technique. This allows twice as many lines per millimeter . . . twice the definition! Resolution is unsurpassed . . . each line is uniform in width and contrast, revealing the most minute variations in the phenomena measured with utmost fidelity. This writing technique combined with the advanced pen-motor design produces a wider frequency response at larger amplitudes. Continuous recording of data can be displayed simultaneously on 8 channels . . . up to 8 independent event markers can be added. Ten chart speeds — 0.1 to 500 mm/sec — provide a 5000:1 chart speed ratio.

The AO Tracemaster has become the new standard of performance for these and many other reasons . . . write now for the full story!

See the AO TRACE MASTER . . . plus other advanced direct writing recorder instrumentation at N.E.C. Booth 242 and N.E.R.E.M. Booth 804.

American Optical
COMPANY

INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

NOW, accurately measure high or low pressures continuously at + 600°F

Statham's new P732 series of high temperature gage and differential transducers accurately measure pressures over a wide variety of ranges and under extreme environmental conditions.

The small and light weight P732 pressure transducers—of rugged stainless steel construction—are temperature compensated for continuous operation to + 600° F. Pressure ranges on the gage and uni-directional differential models are from 0-2 psi through 0-5,000 psi. The bi-directional differential model operates in ranges from ± 1 psi through ± 100 psi.

For your high temperature pressure measurements—for aero-space, nuclear or industrial applications—specify the superior performance of Statham's versatile P732!

COMPARE STATHAM'S COMBINATION OF SUPERIOR PERFORMANCE CHARACTERISTICS

1. Better temperature stability through Statham's new, exclusive zero-length/dimensionless unbonded strain gage.
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4. Combined non-linearity and hysteresis of less than ± 0.75% in *both* high and low pressure ranges.
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For complete data write today to:

Statham STRAIN GAGE DIVISION

Statham Instruments, Inc., 12401 W. Olympic Blvd.
Los Angeles 64, Calif. GRanite 8-0361 TWX: West Los Angeles CAL 6602

CIRCLE 10 ON READER-SERVICE CARD

Editor, I&CS:

In answer to the reader inquiry A-6126 which apeared in the May issue of INSTRUMENTS AND CONTROL SYSTEMS the reader might be interested in the following.

We developed a system for the continuous monitoring of pO_2, pCO_2, and pH in vivo more than two years ago. This system was developed here at the Bowman-Gray School of Medicine of Wake Forest College. In addition to using the system here, we have designed and built similar systems for the Upstate Medical Center of the New York State University and the University of Miami School of Medicine.

If you desire further information with regards to our system, please write directly to the Department of Bio-Medical Engineering, Bowman-Gray School of Medicine, Wake Forest College, Winston-Salem, North Carolina.

John Artesani, Director
Bio-Medical Engineering Dept.
Bowman-Gray School of Medicine
Wake Forest College
Winston-Salem, North Carolina

Editor, I&CS:

In your section on Reader Inquiries a reader desires to make dielectric constant measurements on blood samples (M-42).

Our firm manufactures 3-terminal capacitance bridges of the self-balancing type that can measure capacitance over a range of 0 to 5000 $\mu\mu f$ with an accuracy of 0.25% of full scale or 0.5% of reading (whichever is greater). Sensitivity of the measurement is 0.05%. Readability expressed as the ½ of the smallest increments shown on dial is 0.5%.

Combination of this instrument with a stainless steel and teflon construction dielectric cell should provide a high degree of measurement accuracy.

Leo Stamler, V.P.
Consolidated Airborne Systems, Inc.
New Hyde Park, N. Y.

Editor, I&CS:

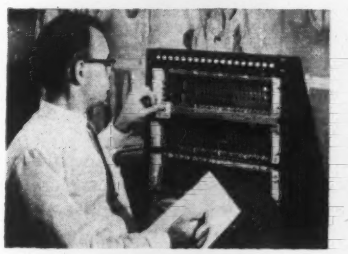
Reference: Reader Inquiry M-26. You may wish to consider for your application the Philbrick Model P2 Differential Operational Amplifier, whose noise and short term drift are approximately at the level of resolution indicated in the paragraph on page 1139 of I&CS, June 1961. There are a number of possible configuration in which such an operational amplifier can be connected.

Daniel H. Sheingold
Director of Applications Engineering
George A. Philbrick Researches, Inc.
Boston 16, Mass.

IGS **NEWS**

"Cybertron" Learns Alogically by Trial and Error

LEXINGTON, MASS.—A special purpose machine so nearly human that it learns, makes decisions, profits by its mistakes and tells how to solve problems that baffle man has been developed by Raytheon Company (Lexington 73, Mass.). Like a human, the Cybertron, as the learning machine is called, is "alogical"—



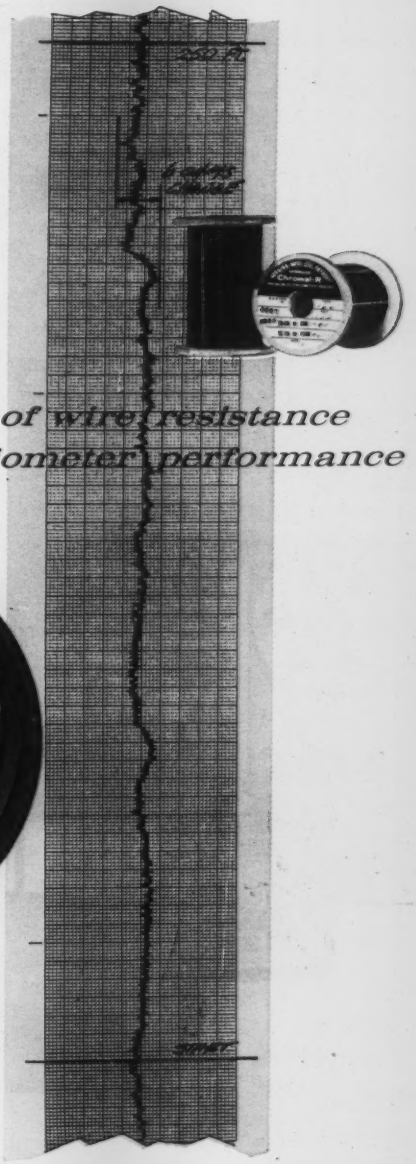
learning by trial and error, relating new situations to past experience, and constantly improving its skill.

The Cybertron is not a computer. It tackles problems for which no formula is known. It figures out its own method of attack, gives the answer, and can tell how it arrived at the answer.

Raytheon has built two models of the learning machine: The smaller of the machines, the K100, is working on military problems under contract from the Department of Defense. The larger one, Cybertron K200, will be capable of recognizing and typing out all typical American word sounds by using its 192 learning elements. Punched tape is used for learning, as well as the memory element. A tape about one foot long stores all the machine learned about dozens of cardiograms, sonar identification, etc.

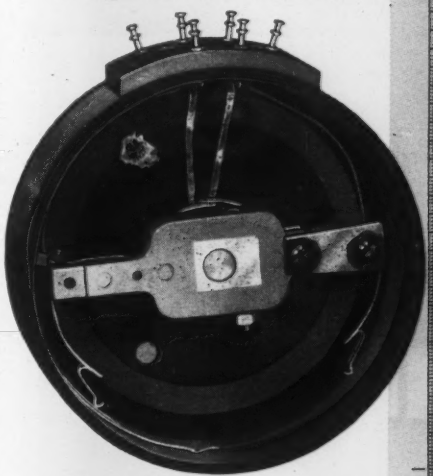
CIRCLE 195 ON READER-SERVICE CARD

INSTRUMENT TECHNICIAN SERVICE ORGANIZATION is affiliating with the Baltimore Section ISA as a sub-section. Purpose of the new organization is "to advance the science of instrumentation . . . by the dissemination of information . . . limiting its membership to those actively engaged in instrument maintenance and service."



This Tape Recording shows the actual deviations in Linearity of Resistance present in a representative length of .0014" Chromel-R wire having a total of 105,750 ohms. Note that greatest change recorded was 6 ohms—which is well within Hoskins Guarantee of .012% maximum deviation in any 250 feet.

How close linearity of wire resistance improves Potentiometer performance



Basic Function of a potentiometer is to control voltage in a circuit by varying electrical resistance. Thus use of wire which possesses superior controlled Linearity of Resistance assures finer accuracy and reliability of operation proportional to shaft rotation.

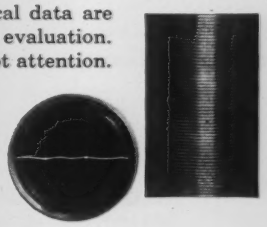
Three reasons why you should specify

Hoskins Chromel-R

Premium Potentiometer Grade 800-Ohm Wire

First, its fine linearity of resistance is controlled to the closest standard of uniformity ever established for potentiometer wire as specified above. Second, it is unconditionally guaranteed to have less than 40 ohms of equivalent noise resistance when received at your plant. And third, it possesses the superior wire roundness required for more uniform winding of mandrels.

Sample spools of Chromel-R with detailed technical data are now available to potentiometer manufacturers for evaluation. Requests on company letterhead will receive prompt attention.



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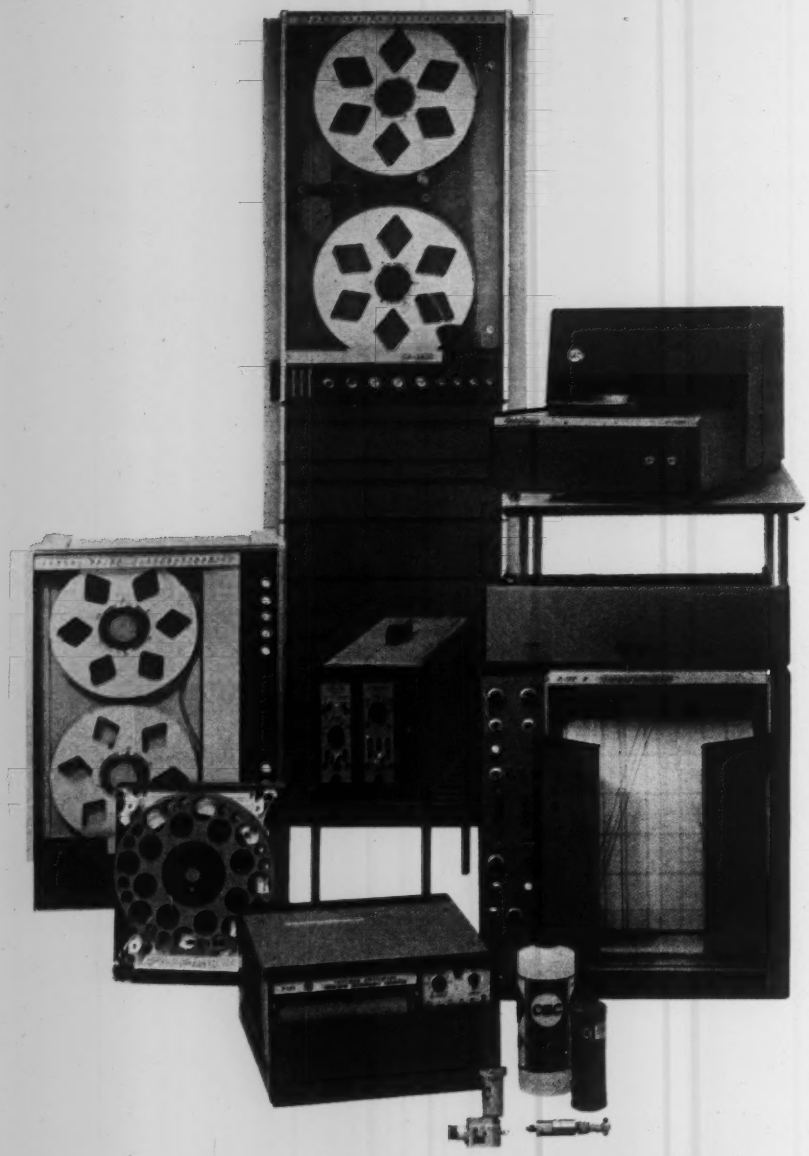
4445 Lawton Avenue • Detroit 8, Michigan • Tyler 5-2860
In Canada: Hoskins Alloys of Canada, Ltd., Toronto, Ontario

Producers of Custom-Quality Electrical Resistance, Resistor and Thermoelectric Alloys Since 1908



recognize the family?

You might. They keep the best of company. And they're just part of the *total* data recording capability only CEC can give you. □ There are Magnetic Tape Recorders for ground station systems and portable use . . . Tape Degaussers . . . D-C Amplifiers . . . Multichannel Recording Oscillographs with a complete line of recording papers and processing chemicals . . . Transducers, too. A whole lot. From data input to output, the CEC family is the most extensive and compatible anywhere! □ Special project? CEC can handle it. As they did with the Mercury Space Capsule Recorder shown in the left middleground. For *any* data recording job, call your nearest CEC office. Or write today for CEC Bulletins 1309-X2 and 1310-X2.

CEC

Data Recorders Division

CONSOLIDATED ELECTRODYNAMICS

PASADENA, CALIFORNIA • A SUBSIDIARY OF BELL & HOWELL

CIRCLE 11 ON READER-SERVICE CARD

Strain Gages Test Automotive Hoists

PHILADELPHIA, PA.—A non-destructive testing method for automotive hoists used for servicing service stations is now applied by Globe Hoist Company, Philadelphia, Pa. to assure that its 8,000-pound lifting capacity hoists meet federal and state structural and manufacturing standards.

Globe uses SR-4 strain gages produced by the Electronics & Instrumentation Division of Baldwin-Lima-Hamilton Corp., Waltham 54, Mass. The strain gages measure, in microinches, the elastic deformation of hoist superstructure members under load. The previously used destructive method of testing required that the hoist was loaded past the yield point to determine reaction to loading.

CIRCLE 196 ON READER-SERVICE CARD

Calibration Service Offered

GLEN COVE, N. Y.—North Hills Electronics, Inc. (Alexander Pl., Glen Cove, N. Y.) has established a standards laboratory and is initiating a service for industry for the measurement and calibration of any type of equipment requiring measurements of d-c voltage, current and resistance to better than 0.01%. Primary voltage and resistance standards which have been certified by the National Bureau of Standards consist of banks of saturated standard cells certified to 0.001% and NBS-type resistors kept in a precisely controlled temperature oil bath, whose temperature is maintained at 28° C within 0.01°. North Hills will certify that its measurements are traceable to the National Bureau of Standards.

CIRCLE 197 ON READER-SERVICE CARD

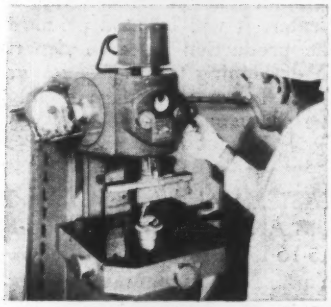
NEREM 61 Meeting-Exhibition

BOSTON, MASS.—The Fifteenth Northeast Electronics Research and Engineering Meeting (NEREM 61) will be held in Boston, November 14-16. Third largest of the nation's electronic engineering events, the meeting-exhibition is sponsored by the Boston, Connecticut, and Western Massachusetts Sections of the IRE. A total of over 90 papers, authored by more than 100 scientists and engineers, will be presented at 22 sessions, including panel workshop day-evening meetings. For information write Lewis Winner, Consultant, 152 W. 42nd St., New York 36, N. Y.

Metrology Training Courses

BURBANK, CALIF.—MetroLonics Institute of Metrology, a Division of MetroLonics, Inc., will offer 12 metrology training courses on 18 separate dates between September 25 and December 15.

Courses covered include: Introduction to Linear Metrology; Introduction to Hydraulic Metrology;



Interferometry and Gage Block Calibration; Gage Block Calibration by Comparison; Thread Calibration; Surface Plate and Flatness Calibration; Gear Calibration and Inspection; Angle Measurements; Autocollimation and Alignment; Inspection Techniques (General); Surface Roughness and Roundness; and Non-Destructive Testing. For information contact Grace Hansen, Registrar, MetroLonics Institute of Metrology, 2201 N. Hollywood Way, Burbank, Calif.

CIRCLE 198 ON READER-SERVICE CARD

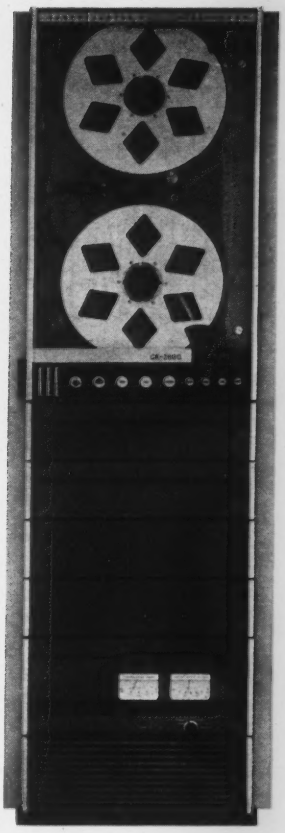
Heat Capacity of Diamond

WASHINGTON, D.C.—The high-temperature heat capacity of diamond has been measured at the National Bureau of Standards using a "drop" method. The data, accurate to within 0.5% over most of the range (323 to 1073°K), join smoothly with low temperature values, and provide a basis for verifying theoretical treatments of diamond lattice dynamics.

The usual procedure for solving problems concerning diamond lattice dynamics is to propose a model of the interatomic forces and, employing the elastic constants and first-order Raman frequency shift, to solve a series of equations leading to a calculated value of heat capacity.

The apparatus consists of a vertical metal tube, the upper end of which is surrounded by an electric furnace and the lower end of which extends into a Bunsen ice calorimeter. Around the lower end of the tube is formed a solid mantle of ice, which

(*Continued next page*)



meet the latest member

For a new product, CEC's GR-2800 Recorder/Reproducer is grown-up indeed. It is more versatile, has a higher stability and costs less than any comparable instrument. Proof is in its features: solid state electronics; direct, FM and PDM modes; plug-in amplifiers interchangeable with PR-3300 electronics; magnetic amplifier tape tension control; six standard speeds 1⅞ to 60 ips; direct record response 100 cps – 100 kc; FM response 0 - 10 kc; and 14-channel recorder/reproducer in a single cabinet. □ Want to know more? Call your CEC office or write for Bulletin CEC 2800-X5.

CEC

Data Recorders Division

CONSOLIDATED ELECTRODYNAMICS

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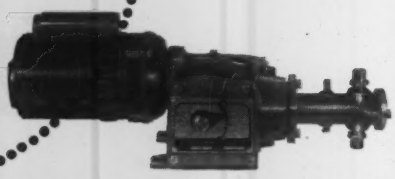
CIRCLE 12 ON READER-SERVICE CARD

NOW, GET

BIG PUMP

FEATURES



IN A SMALL PUMP

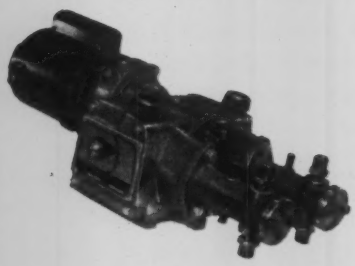
The New W&T Series 100

The Wallace & Tiernan Series 100 Metering Pump borrowed its design from W&T's Heavy Duty Pumps. Big-pump features are retained. Only size is scaled down for jobs like boiler-feed-water treatment.

The Series 100 Pump is one enclosed unit. There are no exposed moving parts. Motor and drive transmit thrust in a straight line. Pumping forces are absorbed by the heavy gear case. There are no rocker arms, no base-plate loads to twist components out of alignment.

Spring-loaded stuffing box assures proper pressure on the packing, prevents over-tightening, automatically adjusts for wear. Packing is easily replaced.

Stroke length is adjusted over a 10 to 1 range while the pump is running. Even in the double simplex, each liquid end is individually adjusted.



The Series 100 Pump delivers 3.2 gph vs 1200 psi, 50 gph vs 100 psi, repeatable within ±1%. You get big-pump performance at a small- capacity price.

For more information, write Dept. L-10. 48

WALLACE & TIERNAN INC.

25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

CIRCLE 13 ON READER-SERVICE CARD

in turn is surrounded by ice water. In the bottom of the calorimeter is a pool of mercury, which is connected to an outside reservoir through a small tube. The water-ice-mercury vessel is sealed from the atmosphere, and is insulated by a surrounding bath maintained at the ice point.

HUMBLE OIL & REFINING CO. has installed a solid-state Bendix G-20 computer at its Houston Research Center. It will be used primarily by the production research department in developing techniques for gathering a larger percentage of oil from the company's reservoirs.

EASTERN ANALYTICAL SYMPOSIUM AND EXHIBIT will be held Nov. 15-16-17 at Hotel Statler-Hilton, New York, N. Y., sponsored by several analytical groups, including NY and NJ Sections of American Chemical Society, Society for Applied Spectroscopy, etc. More than 50 papers will be given, and a panel will discuss "Detectors for Gas Chromatography." For information contact Dr. Saul Gordon, Program Chairman, Fairleigh-Dickinson Univ., Dept. of Chemistry, Madison, N. J.

STACKPOLE CARBON COMPANY announces that *Russell T. Dean* has been appointed Chief Engineer of the Resistor Engineering Department.

DAGE ELECTRIC COMPANY announces that *Malcolm H. Burdett* has been named Chief Engineer.

WARD LEONARD ELECTRIC CO. announces appointment of *Long & Associates, Inc.*, 505 Middlefield Rd., Redwood City, Calif. as their electronic representative in the San Francisco area.

BOOKS

The Application of Elliptical Functions, by Alfred George Greenhill, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 357 pp, 8″, paperbound, $1.75. An unabridged, unaltered republication of the work first published in 1892. Formulas are developed immediately out of definite physical or geometric problems. Each problem is carried through step by step in detail.

CIRCLE 199 ON READER-SERVICE CARD

Semiconductor Digest, published by Systematic Programming & Editing Co., 3604 Woodland, Kansas City, Mo. 346 pp., 9″, ring-binder $12.50. Book consists of specifications on diodes, rectifiers, variable capacitors. Types of twenty-seven major manufacturers are listed. Electrical specs are arranged for immediate selection of type to solve specific application or replacement problems.

CIRCLE 200 ON READER-SERVICE CARD

Advances in Astronautical Sciences, Vol. 5, [c1960] American Astronautical Society, Inc. distributed by Plenum Press, Inc., 227 West 17th St., New York 11, N. Y., 356 pp., 10″, clothbound, $8.00. Volume presents Proceedings of the second Western National Meeting of the American Astronautical Society. Contains 26 reports on theoretical and experimental aspects of the most recent astronautical research.

CIRCLE 201 ON READER-SERVICE CARD

Digital Computer Principles, by Wayne C. Irwin, [c1960] D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J. 321 pp., 9″, clothbound, $8.00. A book for the beginner. Emphasis is on principles, illustrated with examples of circuits, devices, and systems. The author starts with the details and synthesizes a general system.

CIRCLE 202 ON READER-SERVICE CARD

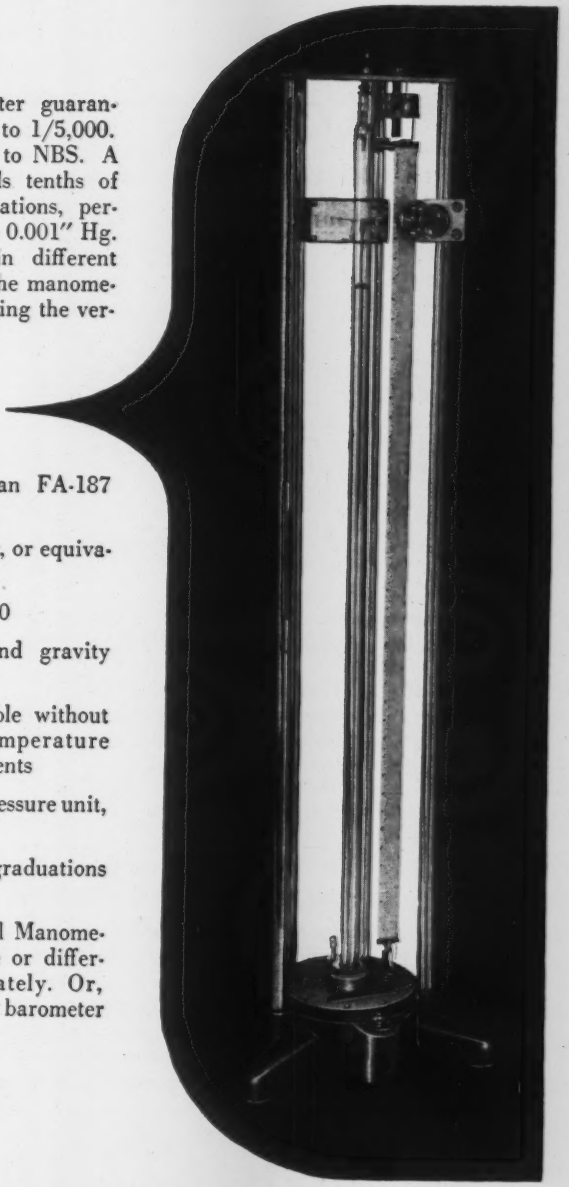
Digital Computer and Control Engineering, by Robert Steven Ledley, [c1960] McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y., 835 pp., 9″, clothbound, $14.50. An elementary engineering textbook intended for senior undergraduates. Covers all aspects of the field from a detailed engineering point of view.

CIRCLE 203 ON READER-SERVICE CARD

Rocket Propellant Handbook, by Boris Kit and Douglas Evered, [c1960] The Macmillan Company 60 Fifth Ave., New York 11, N. Y.,

(*Continued next page*)

GET W&T U-Tube accuracy with Fast, Direct Readout.. PRECISION MERCURIAL MANOMETER



The FA-187 Manometer guarantees readings accurate to 1/5,000. Accuracy is traceable to NBS. A magnetic vernier reads tenths of the main scale graduations, permits direct readings to 0.001″ Hg. Five vernier scales in different units allow changing the manometer scale without changing the vernier.

The Wallace & Tiernan FA-187 Manometer also gives:

- ★ Range: 800 mm. Hg, or equivalent
- ★ Sensitivity: 1/25,000
- ★ Full temperature and gravity compensation
- ★ Scales interchangeable without recalibration of temperature and gravity adjustments
- ★ Calibration in any pressure unit, or equivalent
- ★ One or two sets of graduations on a single scale

Use the W&T Mercurial Manometer to measure absolute or differential pressures accurately. Or, quickly convert it to a barometer on the job.

For more information, write Dept. A-134.48

WALLACE & TIERNAN INC.
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

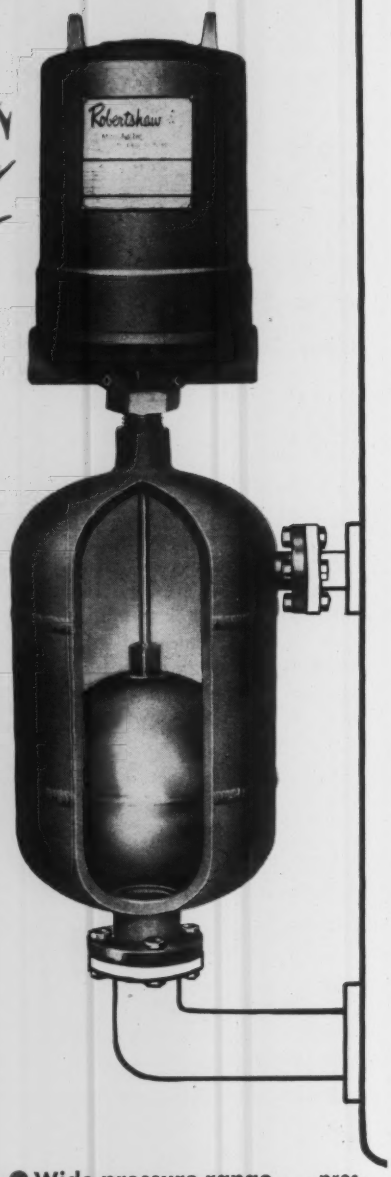
CIRCLE 14 ON READER-SERVICE CARD

NEW CERAMIC MAGNET Level Switches

FOR LIFETIME SERVICE . . . MULTIPLE FUNCTIONS

Start pumps, open or shut valves, sound alarms automatically . . . with these new high-load "Level-Ac" liquid level controls by Robertshaw, actuated by ceramic permanent magnets.

Designed for open or pressurized systems, these float-type switches provide constant control of levels in boilers, process vessels or other containers, with a long list of major advantages:



- **Extreme resistance to demagnetization** . . . highest of any commercial magnetic material.
- **Multiple switching functions** (up to 7 combinations) in small housing due to higher concentration of magnetic force.
- **Pneumatic or electric models** . . . explosion-proof housing available for electric switches.
- **Choice of mountings** . . . all-welded or flanged external float cages; top-mounting with tubular or 3-rod guides; side-mounting.
- **Wide pressure range** . . . pressure-equalizing floats for high-pressure applications.
- **Fewer moving parts** for trouble-free operation, lower cost.
- **"High-load" snap switch** . . . avoids need for leveling.

Just out! Complete description in new folder RL-765

Robertshaw

Robertshaw-Fulton Controls Company

MR. CONTROLS

FULTON SYLPHON DIVISION • KNOXVILLE 1, TENNESSEE

CIRCLE 15 ON READER-SERVICE CARD

354 pp., 9¼", clothbound, $12.50. An unclassified reference work describing nearly a hundred chemicals for possible use as rocket propellants, including fuels, oxidizers, and monopropellants. Covers physical and chemical properties, performance characteristics, etc. and contains valuable tabulated data for each substance.

CIRCLE 204 ON READER-SERVICE CARD

Pocket Handbook for Industrial Instrumentation and Process Control, 1960, published by Siemens & Haske A.G., Room 6800, Empire State Building, New York, N. Y., 239 pp, 6¾", clothbound $2.00. Contains 44 tables from Greek alphabet to effect of neutron bombardment, and 14 chapters on measurements of basic variables and automatic control as well as data processing.

CIRCLE 205 ON READER-SERVICE CARD

Basics of Induction Heating, by Chester A. Tudbury, in two volumes, [c1960] John F. Rider Publishers, Inc., 116 W. 14th St., New York 11, N. Y., 140 plus 144 pp., 9", soft cover, $3.90 each. Intended for students in high schools, technical institutes, and industrial training courses. Explains what induction heating is and how it works. Uses "pictured text" approach. Has review questions at the end of each section.

CIRCLE 206 ON READER-SERVICE CARD

Digital Computer Fundamentals by Thomas C. Bartree, [c1960] McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y., 342 pp., 9" clothbound $6.50. After introduction to functions and applications of computers, circuitry is explained and major divisions with elements used in each of them are thoroughly described.

CIRCLE 207 ON READER-SERVICE CARD

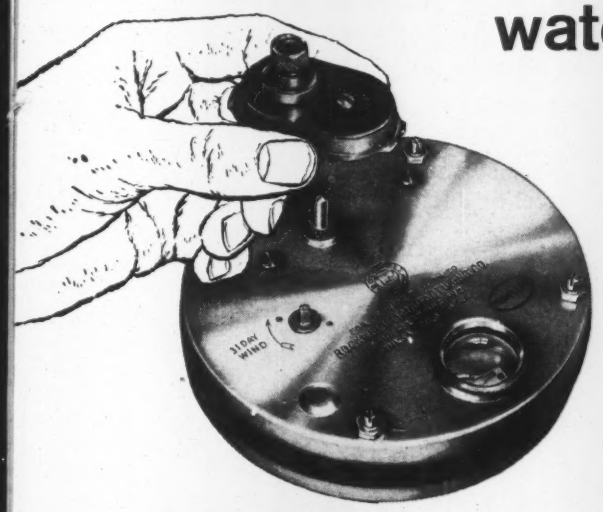
Ordinary Differential Equations and Their Solutions by George M. Murphy [c1960] D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 451 pp., 9", clothbound $8.50. Said to be first book in English presenting a compendium of methods for solving ordinary differential equations, supplemented by a tabulation of some 2,000 equations and their solutions.

CIRCLE 208 ON READER-SERVICE CARD

Computer Logic by Ivan Flores, [c1960], Prentice-Hall, Inc., Englewood Cliffs, N. J., 458 pp., 9", clothbound $12.00. Requiring little engineering or mathematical background, book describes and illustrates with block diagrams how a computer is put together and how it works, and provides practice and drill problems necessary for acquiring facility with computer concepts.

CIRCLE 209 ON READER-SERVICE CARD

This "jeweled" escapement brings you fine watch quality in chart drives



See how easy it is to convert to seven different rotation rates

The main arbor on the basic chart drive has a rotation rate of seven days. Economical snap on turrets convert this rate to 8 day, 15 day, 16 day, 24 day, 30 day, 31 day and 24 hour rotation. No tools are required and you can even change chart rotation without removing the drive from the instrument.

Now, for the first time you get the extra value of a jeweled movement. This superior construction makes Rockwell chart drives more accurate and sensitive than ordinary chart drives. It requires less power to drive and is extremely durable since there are seven hard jeweled surfaces to overcome friction and wear.

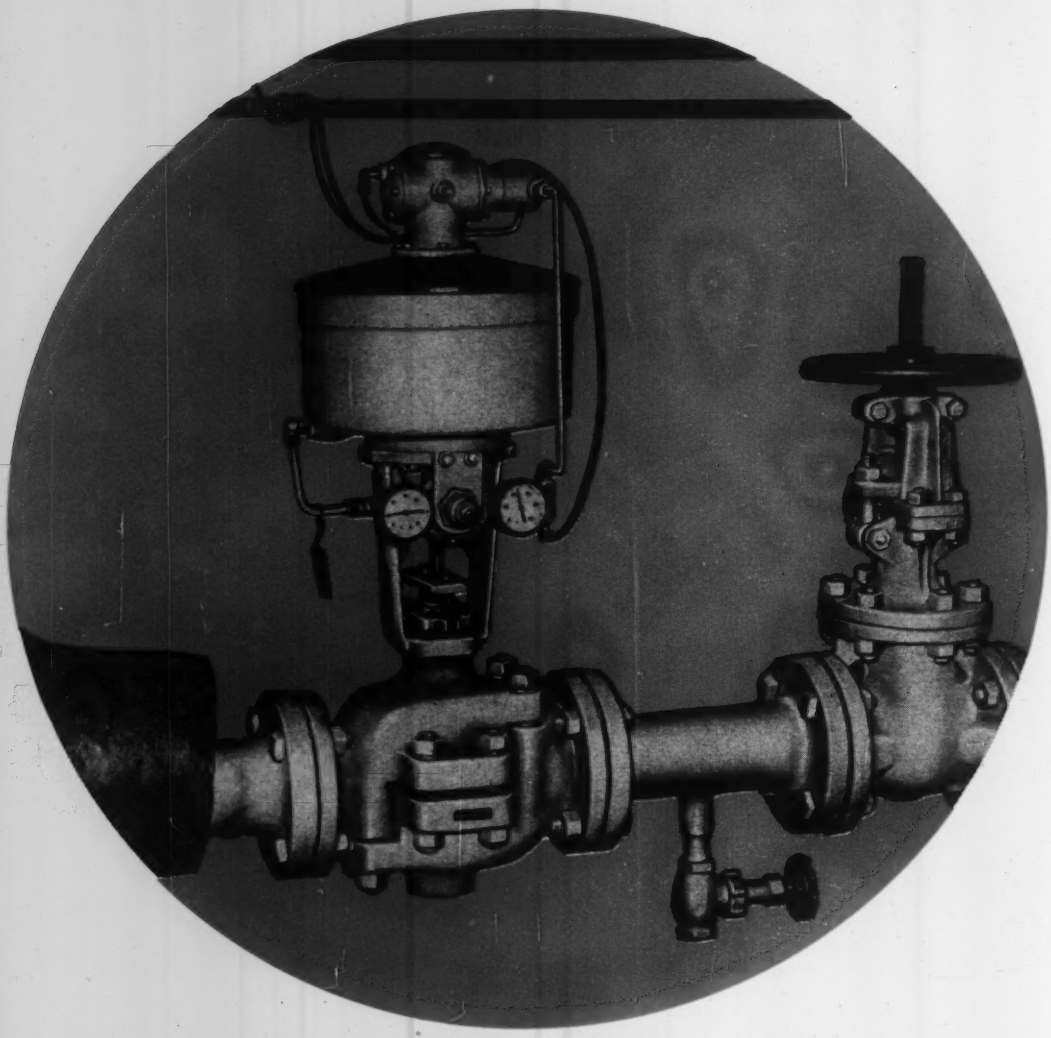
You can use these jeweled movement chart drives *with profit* to power all your recording instruments. They will adapt into practically any instrument case. Speed changing turrets (see left) permit varying rotation rates at will. Write for bulletin. Rockwell Manufacturing Company, Dept. 58-K, Pittsburgh 8, Pa. In Canada, Rockwell Manufacturing Company of Canada, Ltd., P.O. Box 420, Guelph, Ontario.

JEWELED CHART DRIVES

another fine product by

ROCKWELL

CIRCLE 16 ON READER-SERVICE CARD



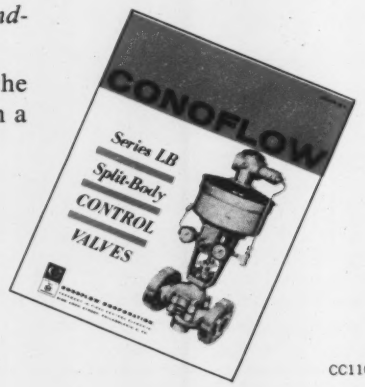
A Split-body Valve is not a "Specialty"

...it is a practical, all-purpose control valve

The Conoflow Series LB valve shown is handling 100 psi steam. This is not unusual. Actually, the vast majority of the thousands of LB valves in service are handling water, steam and other common plant fluids. In fact, more than 80% of LB orders call for *standard* cast steel or ductile iron construction.

LB valves were selected because they give *better control, greater dependability* and *unequalled maintenance savings,* all at a *low initial cost.*

More and more users are standardizing on the LB valve right down the line because they know that LB valves mean *less downtime,* resulting in a more profitable plant operation.



Write for NEW Bulletin LB-4. Be convinced.

CONOFLOW
SUBSIDIARY
WALWORTH

CONOFLOW CORPORATION

FOREMOST IN FINAL CONTROL ELEMENTS

2100 ARCH STREET, PHILADELPHIA 3, PA.

CC110R

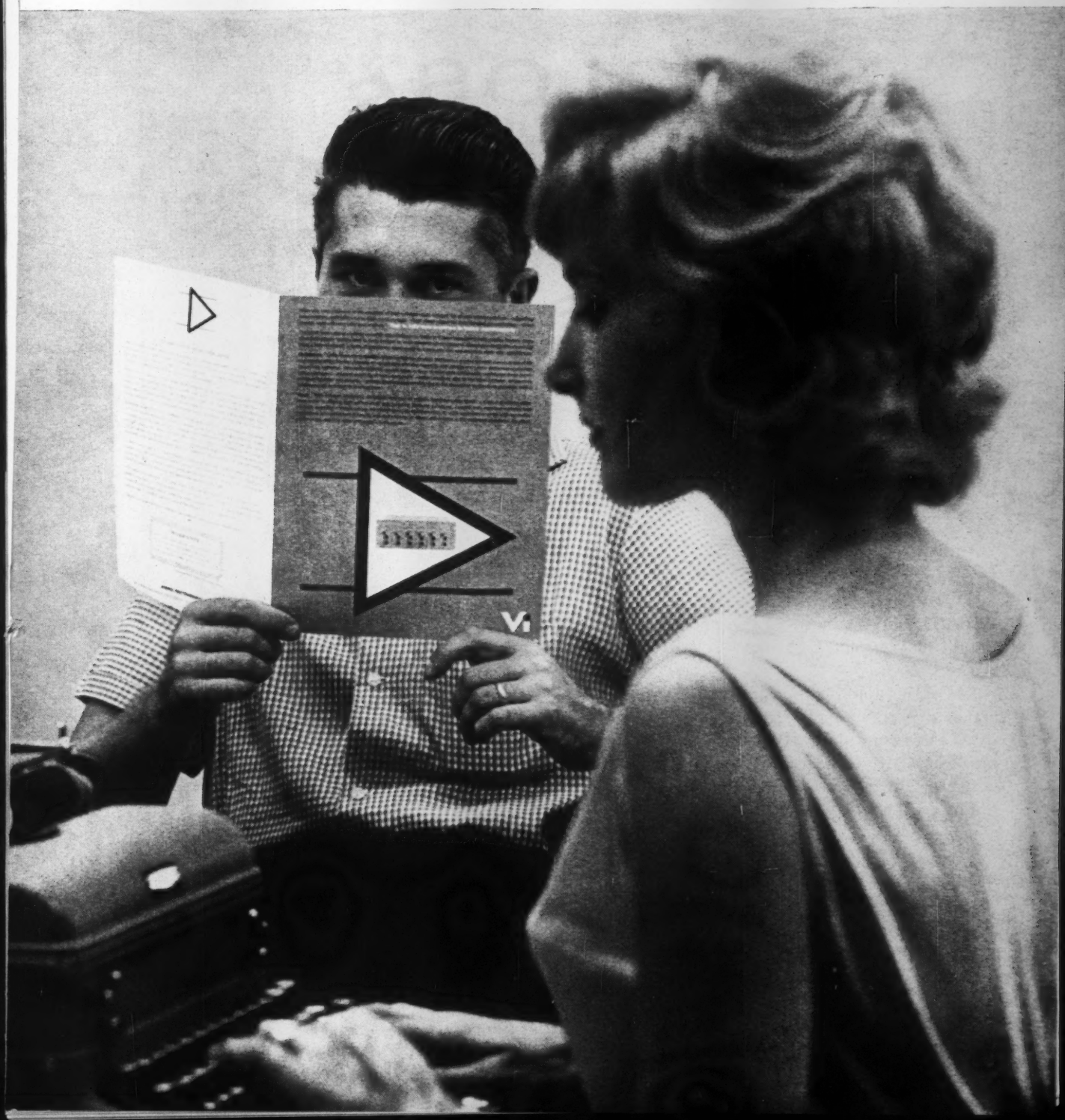
CIRCLE 17 ON READER-SERVICE CARD

CIRCLE 18 ON READER-SERVICE CARD →

nearly everybody
in electronic
laboratories reads
Video Instrument catalogs...
get yours!

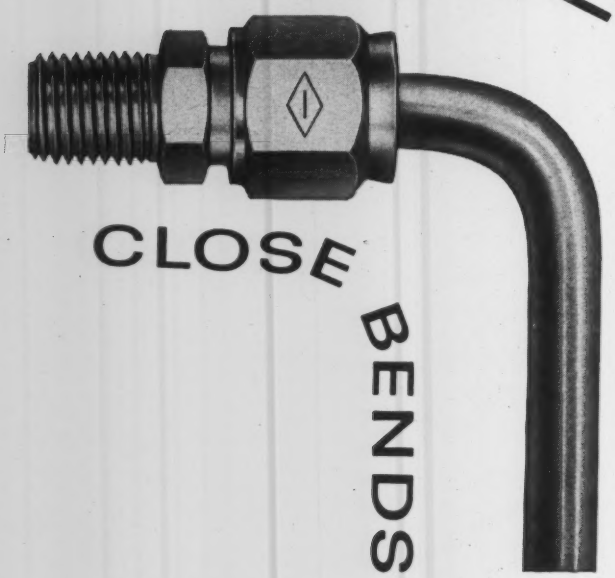
When your mind gets back to amplifiers, remember that Video Instruments now provides four types of laboratory and field tested solid state amplifiers—chopper stabilized, sub-miniature airborne, galvanometer driver, and "pure" direct coupled. Complete specifications are available in Vi's latest catalog—and, as a reward for promptness, we will also send you a technical discussion of common mode rejection. Write Video Instruments—then get back to work.

VIDEO INSTRUMENTS COMPANY, INC. *3002 Pennsylvania Avenue, Santa Monica, California* Vi



no
problems
with...

CLOSE BENDS

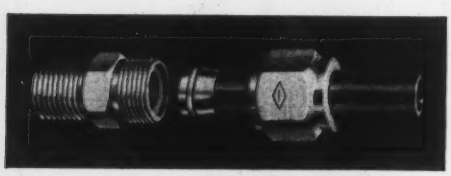


CLOSE BENDS

With Hi-Seal® fittings you can make tube bends close to the fitting—in fact, right next to it. Here Hi-Seal is in a class by itself.

Hi-Seal's simplified design with flareless butt joint makes this possible. The advantages? More compact layouts. Save on tubing. Shorten installation time by as much as 50%. Gain utmost reliability. SAVE MONEY. To get these advantages, insist on Hi-Seal.

For complete information, write for Bulletin 3108.



BUTT JOINT HI-SEAL

IMPERIAL EASTMAN

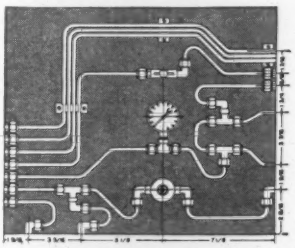
Imperial-Eastman Corporation General Offices: 6300 West Howard Street, Chicago 48, Illinois

In Canada: Imperial-Eastman Corporation (Canada) Ltd., Toronto

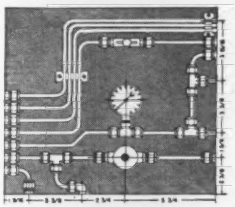
CIRCLE 19 ON READER-SERVICE CARD

Close Bends with Hi-Seal Save Time, Space, Tubing

Look at what you can do when you use Hi-Seal fittings:



This typical layout has "old-fashioned" tube fittings. Layout area, 257 sq. in.; 12.7 ft. of tubing; *installation time 2 hr., 34 min.*



Same layout with Hi-Seal tube fittings. Layout area reduced 32% to 175 sq. in.; tubing reduced 40% to 7.7 ft.; *installation time reduced nearly 50% to 1 hr., 20 min.!*

All this is possible because of Hi-Seal's exclusive flareless, butt joint design. This means that tube bends may be made right next to the fittings. Even direct tube connections may be made without any extra loops to allow for tube entry into the fitting.

One Fitting for the Entire System

However varied your requirements may be, Hi-Seal meets them. Available in all styles, sizes and combinations, plus a variety of metals: steel, stainless steel, brass, aluminum, titanium, Monel, etc.

Now Imperial-Eastman meets all your requirements for hydraulic-pneumatic-flow system components: tube fittings, valves, couplings, flexible and rigid hydraulic and pneumatic hose, thermoplastic tubing, tubing tools.

FITTINGS

IMPERIAL-EASTMAN

ICS EVENTS

November 1-3

Annual SESA Meeting, Hotel New Yorker, New York, N. Y. For information write B. E. Rossi, Executive Secretary, Society for Experimental Stress Analysis, 21 Bridge Square, Westport, Mass.

November 2-3

Annual Instrumentation Conference, Louisiana Polytechnic Institute, Ruston, La. For information write the above.

November 5-8

American Documentation Institute annual convention, Somerset Hotel, Boston, Mass. and Kresge Auditorium, M.I.T. For information write P. D. Vachon Melpar, Inc., Applied Science Division, 11 Galen St., Watertown 72, Mass.

November 6

Ninth Hot Laboratory and Equipment Conference, Conrad Hilton Hotel, Chicago, Ill. For information write American Nuclear Society, 86 East Randolph St., Chicago 1, Ill.

November 6-8

Sixth Annual Special Technical Conference on Non-Linear Magnetics, sponsored by AIEE and IRE, Statler Hilton Hotel, Los Angeles, Calif. For information write Dr. T. Bernstein, Space Technology Labs., P. O. Box 95001, Los Angeles 45, Calif.

November 13-16

Seventh Annual Conference on Magnetism and Magnetic Materials sponsored by IRE, AIEE, AIP, et al. For information write Dr. Peter B. Myers, Motorola Semiconductor Products Div., 5005 E. McDowell Rd., Phoenix, Ariz.

November 14, 1961

Symposium on Electronic Systems Reliability sponsored by Kansas City IRE Section Linda Hall Library Auditorium, 5109 Cherry, Kansas City, Mo. For information write F. A. Spies, Bendix Corp., Kansas City Div., P. O. Box 1159, Kansas City, Mo.

November 14-16

Fifteenth Northeast Electronics Research and Engineering Meeting and Exhibit (NEREM) Commonwealth Armory and Somerset Hotel, Boston, Mass. For information write Lewis Winner, Consultant, 152 W. 42nd St., New York 36, N. Y.

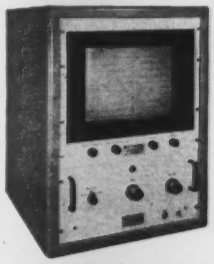
November 15-17

Eastern Analytical Symposium sponsored by ACS, et al. Hotel Statler Hilton. For information write Dr. Arnold Mowitz, Interchemical Corp., 432 West 45th St., New York 36, N. Y.

December 12-14

Eastern Joint Computer Conference (EJCC), sponsored by IRE, AIEE, ACM, Sheraton-Park Hotel, Washington D. C. For information write Bruce Oldfield, IBM Corp., 326 E. Montgomery, Rockville, Md.

ATL PROFILE MONITOR

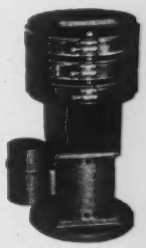


Bar-graph display of pressure, temperature, velocity, and other variables on 17" CRT. Scans up to 48 channels, each 20 times per second. Alarm functions when set point is exceeded.

ATL DELTASWITCH

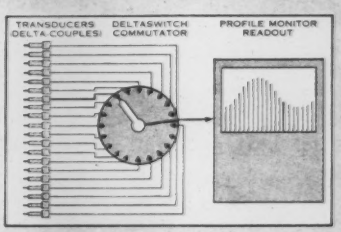
HIGH SPEED MERCURY JET COMMUTATOR

Provides high sampling rates and long, trouble-free operation. Uses mercury jet in place of conventional wiper arm. Models available with 64, 81, or 100 channels per pole, single or multiple poles, for 1200 or 1800 rpm operation.



TYPICAL SYSTEM

Illustrated below is a system combining ATL thermocouples, Deltaswitch, and Profile Monitor to display temperature gradients along a surface or at various depths in a heat shield.



For detailed information write:

ADVANCED TECHNOLOGY LABORATORIES

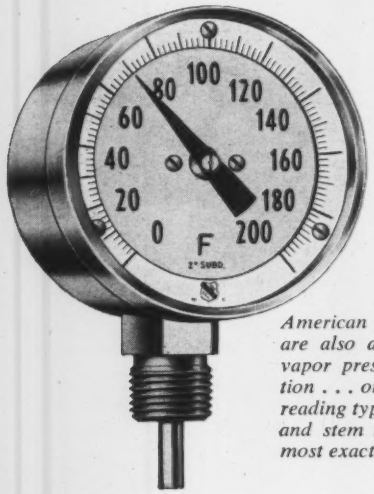
A DIVISION OF AMERICAN-Standard

369 WHISMAN ROAD • MOUNTAIN VIEW, CALIFORNIA

CIRCLE 20 ON READER-SERVICE CARD

sharp

AMERICAN BI-METAL THERMOMETERS make accurate temperature readings sharp and sure at all check points



American Dial Thermometers are also available in mercury, vapor pressure, and gas actuation . . . on-the-spot and distant reading types . . . in sizes, ranges and stem lengths to meet your most exacting requirements.

sensitive

Any way you look at an American Bi-Metal Thermometer, you see exact working temperatures.

The two-level "Maxivision®" dial eliminates parallax effects. Numerals are on the lower level. Graduations are on the outer raised ring dial which presents a sheared edge to the tip of the pointer and in the same plane. To make readability even more accurate, the glass and graduated dial are closely spaced.

American Bi-Metal Thermometers are made of weather-proof stainless steel. All joints are welded to solid unity, then polished smooth so corrosion won't build up and destroy the thermometer's usefulness. And, you don't have to discard this thermometer even if the glass is ever broken. The bayonet lock bezel makes replacement easy.

Learn about the high sustained accuracy and long service life built into American Bi-Metal Thermometers. Phone your nearby industrial supply distributor for help in selecting the right type for each temperature check point in your plant. Or write for Catalog 155.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

AMERICAN INDUSTRIAL THERMOMETERS

A product of

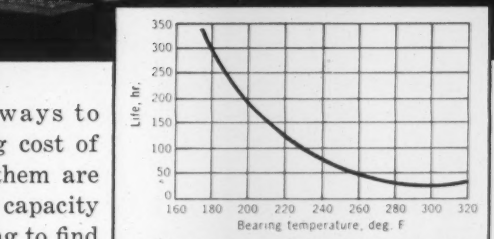
MANNING, MAXWELL & MOORE, INC.

Gauge and Instrument Division • Stratford, Connecticut

Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario
Latin America: Export Division, Chrysler Building, New York, N. Y.
Europe: Manning, Maxwell & Moore, S. A., Fribourg, Switzerland

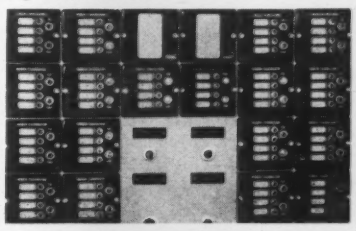
CIRCLE 21 ON READER-SERVICE CARD

THE "SUPERVISOR" THAT SHOWS YOU EASY PLACES TO CUT PLANT OPERATING COSTS



Temperature vs. fatigue life of a tin-base babbitt bearing at a unit load of 2000 psi.

Dozens of machines at as many different locations can be watched from a single panel for signs of excessive bearing operating temperatures.



There are three basic ways to combat the steadily rising cost of plant operation. Two of them are hard ways: buying higher capacity initial equipment, or, trying to find more efficient equipment. So many advances have already been made in these directions that any overall economy you may gain in the future promises to be small.

But the third way to save—and this is the easy one—is to increase the *reliability* of your equipment, thereby lowering your maintenance expenses and perhaps even reducing the amount of standby equipment needed. *Omniguard* is a proven *supervisory system* that enables you to do just this. It continuously supervises bearing temperatures in your heavy rotating equipment, preventing bearing failures and *extending* bearing life, sometimes by years. Omniguard also monitors lube oil pressures, pump suction and discharge pressures, and other variables of a critical nature. Monitors and indicators installed at any convenient location away from the equipment, display the readings and provide warning signals and automatic shut-down of equipment if desired.

Omniguard keeps constant watch on the important temperatures and pressures in your plant—makes it easy for you to avoid the expensive repair jobs and down time that would otherwise be part of your operating expense.

For complete information on the Edison Omniguard System, and the variations available for different kinds of machinery, write for Catalog 3036D.

Thomas A. Edison Industries
INSTRUMENT DIVISION
41 LAKESIDE AVENUE, WEST ORANGE, N. J.

CIRCLE 22 ON READER-SERVICE CARD

To prove what you think must be so...

CIRCLE 23 ON READER-SERVICE CARD

That's the toughest job. Somebody's got to pore over every ounce of research that's gone before. And look into every possible place for a clue...or even a place to get started. That's where CEC comes in. That's all CEC men do for a living—discovering the way, or ways, to measure, record, and analyze what you have to know. And building the instruments to get the job done. Are you looking for a place to start? Or ready to check out an elusive clue now? Call in a man from the CEC sales and service office nearest you. He might know a way.

CEC

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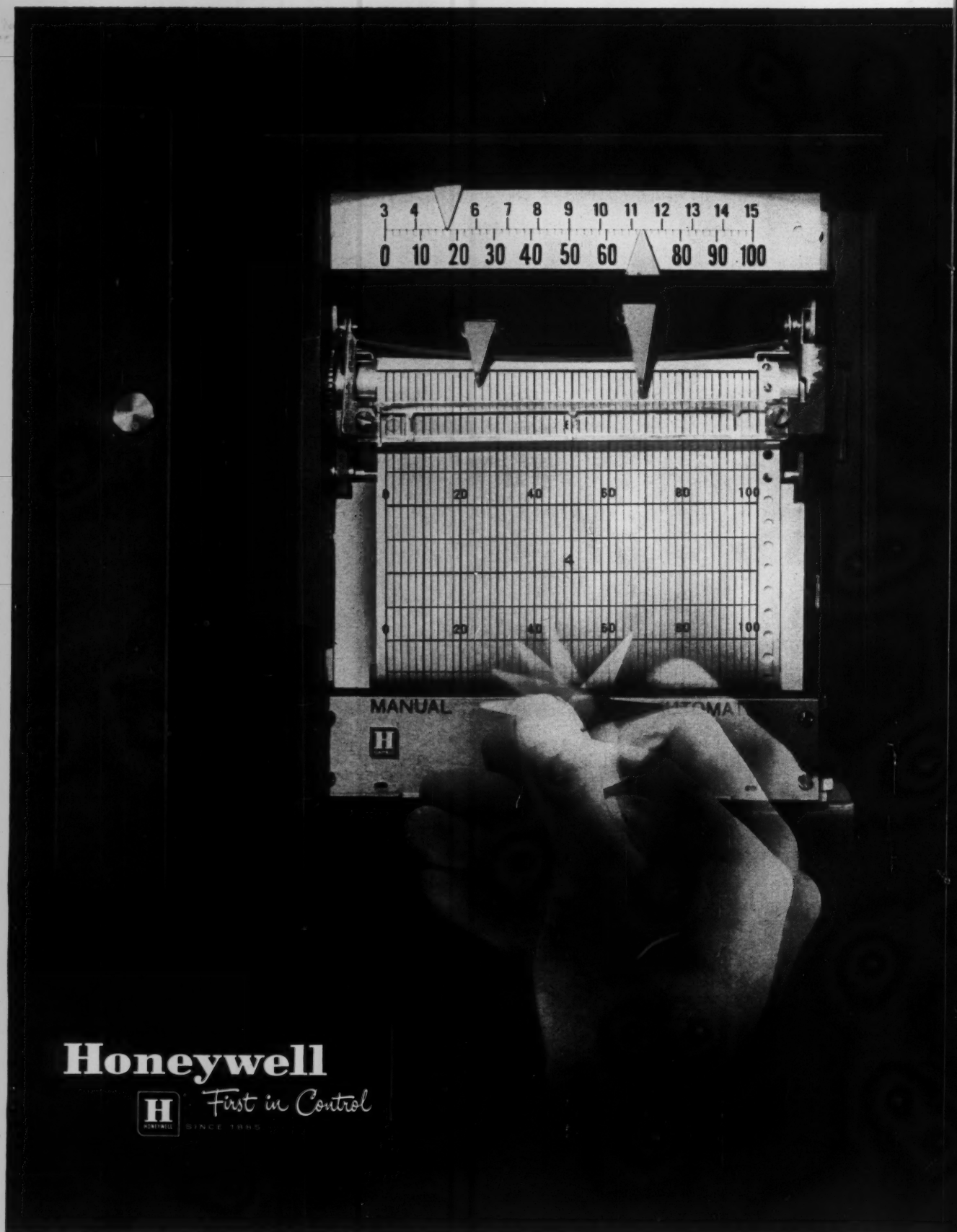
PASADENA, CALIFORNIA • A SUBSIDIARY OF BELL & HOWELL

DATA RECORDERS DIVISION • ANALYTICAL & CONTROL DIVISION • TRANSDUCER DIVISON • CONSOLIDATED SYSTEMS CORP. • CONSOLIDATED VACUUM CORP.



CIRCLE 24 ON READER-SERVICE CARD

Automatic Switching Eliminates Matching of Pressures *with*

New Honeywell PneumatiK Tel-O-Set Instrumentation

Honeywell brings new features, new performance to small case instruments with the introduction of *PneumatiK Tel-O-Set Instrumentation.* Here are just a few of the many new features:

Automatic Switching Just a flip of the control lever switches the instrument from automatic to manual or vice versa. There are no bumps, no delays, no matching of pressures required. This simplified switching makes cascade control systems practical for the operator.

Easily accessible adjustments Zero and damping adjustments to pen can be made while the pen is recording. Effects of adjustments can be seen *while* they are being made. Since it is not necessary to withdraw the recording chassis to make adjustments, there is no possibility of causing a pen zero shift.

Interchangeable chassis and controllers Recording and indicating chassis are interchangeable. Just pull out one chassis and plug in the other. Quick-connect air terminals eliminate the need for tubing connections. Two- and three-mode controllers with backset adjustments are also completely interchangeable.

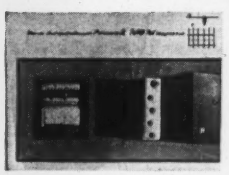
Easy-to-read, easy-to-change 4-inch charts Pen position on the 4-inch chart permits instantaneous reading of variables at all times. Pen arm design also permits rectilinear recording. Front-loading, tilt-out chart drive makes it easy to change chart rolls in a matter of minutes.

All cases fit 6 x 6 cutouts All models fit standard panel cutout of 6″ x 6″. Overall dimensions: 6¾″ wide; 7½″ high; 15¼″ deep.

Calibrated control adjustment Adjustments to controller can be easily made from back of the panel by removing controller cover. Calibrated dials for each adjustment ensure precise setting of proportional band, reset and rate values. Optional front-set control adjustments make it easy to set control from front of panel.

Easy to remove components To remove any particular component from the case, it is only necessary to loosen a screw or lift a latch.

HANDY DEMONSTRATOR-IN-PRINT Get the full story on new Honeywell *PneumatiK Tel-O-Set* Instrumentation by writing for this handy demonstration-in-print. This booklet covers in words and pictures all the important installation, operation and maintenance features of the new line. It will help you evaluate the many advantages *PneumatiK Tel-O-Set* holds for your process. Send for it today. MINNEAPOLIS-HONEYWELL, 4402 Wayne Avenue, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.



HONEYWELL INTERNATIONAL Sales and Service offices in principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

ICS TRENDS

Over 7000 general-purpose computers are expected to be delivered during the next 24 months, says 7th semi-annual John Diebold & Associates computer census. The JD&A Census indicates that 5371 computers had been delivered by June 30, 1961. Of this total, 3776 are "vacuum tube" machines and 1595 are the newer transistorized (solid state) systems. Of the 7000 G-P computers on order, 4800 are small-size IBM 1401, 450 are desk-size IBM 1620, 350 are medium-size IBM 7070- Series,130 are large-size IBM 7090.

More than $2.7 billion will be spent for space research in fiscal 1962. NASA will receive $1.7 billion; military $1 billion.

Scientists and engineers employed in the performance of research and development in the natural sciences in the United States numbered approximately 331,000 in 1958, an increase of almost 50% over comparable figure of 223,000 for 1954, the NSF survey base year, says NSF.The upward trend reflects the rise of about 95% in expenditures (current operating costs) for the conduct of research and development.

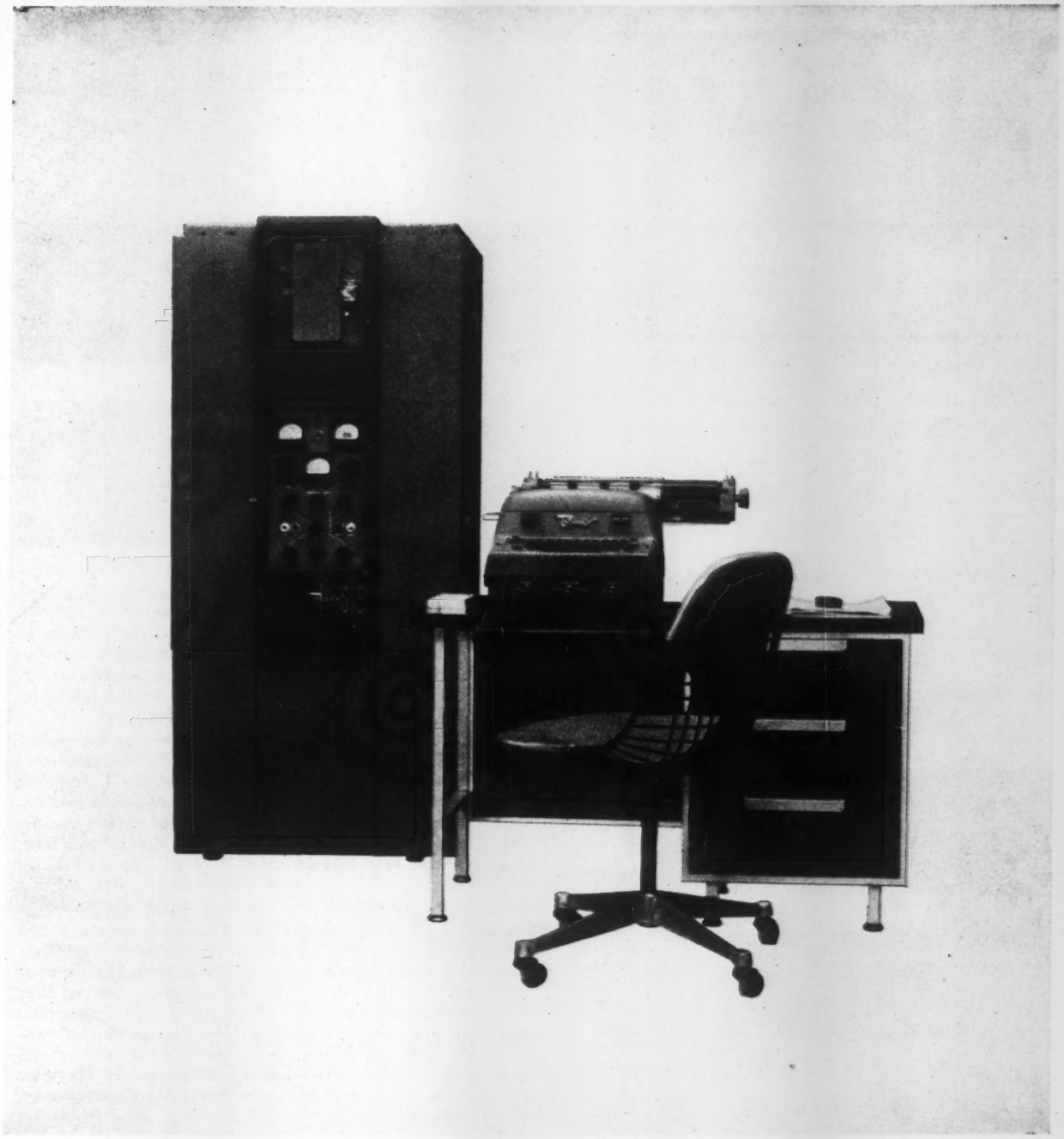
During 1960, the Federal Power Commission authorized natural gas construction involving more than $787.6 millions and including 5,784 miles of natural gas pipelines. At the end of 1960, proved recoverable reserves of natural gas were at an all-time high of 263.8 trillion CF. Despite a net production of 13.1 trillion CF during the year, the proved reserves at the end of 1960 were 1.2 trillion CF greater than at the end of the preceding year, says Gas Appliance Manufacturers Assoc.

Total end-use need for four energy consuming sectors (residential, commercial, industrial, motive) was equivalent to 26,000 trillion Btu in 1959. The sum of separate projections of end-use energy requirements in each consuming sector is expected to reach 47,000 trillion Btu in 1970, and 64,500 trillion Btu by 1980, says Oil Gas Journal.

Oxygen production has doubled in last five years, reaching 4.5 million tons in 1960, is expected to reach 14 million tons by 1970, says Chemical Processing. Steel industry uses 45% of total (open hearths, blast furnaces, L-D converters, Kaldo converters, scarfing, etc.); chemical industry uses about 40% (making acetylene, methanol, ethylene oxide, ammonia, ozone, hydrogen peroxide, formaldehyde, etc.); remainder is used in medical and aviation breathing, welding, metal cutting, polishing, etc.). Major chemical uses (tons/year are as follows: acetylene—900,000; synthesis gas (ammonia and methanol manufacture)—900,000; propane, butane oxidation products—150,000; ethylene oxide—125,000.

Gas industry sales in 1960 climbed 12%, to a total of nearly $5.7 billion—and it is expected that they will pass the $6 billion-mark in 1961. Reserves reached 262.6 trillion CF at the beginning of 1960. New reserves discovered in 1959—nearly 6 trillion CF—were the third highest on record, exceeded only by discoveries in 1957 and 1953, says AGA.

← CIRCLE 24 ON READER-SERVICE CARD



Proven Performer

THE BENDIX G-15 COMPUTER...is daily demonstrating its ability to save time and money at hundreds of installations in industry after industry...has established an overall reliability record of 97.4%. Other reasons behind continuing G-15 leadership: ease of use...over 1000 programs immediately available at no charge...versatility and expandability resulting from the widest selection of input-output accessory units. Continuing systems support in depth and a vigorous users EXCHANGE organization combine to broaden application usefulness...assure maximum system effectiveness at minimum cost. Speaking of cost, G-15 proven performance is yours for as little as $1,485 a month. Investigate the Bendix G-15...prove to your own satisfaction how its demonstrated superiority can bring important time and dollar savings to your organization.

Call your Bendix Computer representative, or write:

Bendix Computer Division

DEPT. J-35, LOS ANGELES 45, CALIFORNIA

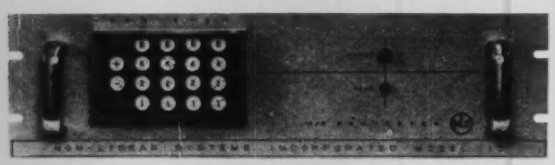
THE Bendix CORPORATION

CIRCLE 25 ON READER-SERVICE CARD

NEW!

4 MAJOR DIGITAL VOLTMETER ADVANCEMENTS FROM NLS

Now Make 15,000 Highly Accurate DC Measurements/Sec... Measure VDC-Ratio-Ohms to Full 5 Digits ...Buy a Quality DVM or Ohmmeter for $1,460... Use Digital Voltmeters in Go/No-Go Testing

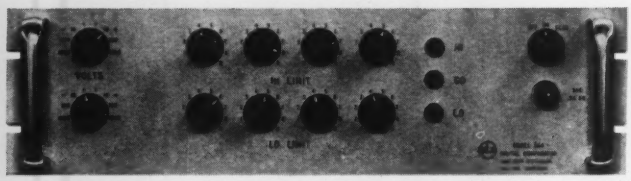


MODEL 15 A/D CONVERTER

M25 VOLT-RATIO-OHMMETER

484A VOLTMETER-RATIOMETER

784 DIGITAL OHMMETER



MODEL 54A DIGITAL COMPARATOR

MODEL 15 A/D CONVERTER — 4-digit instrument bringing high accuracy to high-speed measuring and data logging . . . 15,000 measurements/sec . . . accuracy: ±0.01% ± 1 digit from 0 to full scale from 0 to 40°C . . . any range from ±1 to ±100 v. full scale . . . true bipolar digital output, high output current, uses internal or external clock . . . constant input impedance. Price: $6,985.

M25 5-DIGIT VOLT-RATIO-OHMMETER—ultra-reliable instrument measuring DC volts, DC ratio and ohms with full 5-digit resolution of 0.001% and accuracy of ±0.01% of reading ± 1 digit over entire range of ±0.0001 to ±999.99 v. and .1 ohm to 1 meg . . . 10 to 1000 meg input z . . . twice speed of fastest stepping switch DVMs . . . advanced transistor circuitry with ultra-reliable mercury relays with 171 years life expectancy . . . input filter . . . remotely programmable . . . fully automatic . . . data logging output . . . AC or low-level DC with accessories. Price: $5,685

484A DIGITAL VOLTMETER-RATIOMETER—most versatile and highest quality instrument at low cost . . . measures ±0.001 to ±999.9 VDC and DC ratio up to ±99.99% . . . ±0.01% accuracy . . . 10 meg input . . . auto range and polarity . . . input filter . . . built-in auto print control . . only a few dollars more than cheapest DVMs without such quality features as plug-in stepping switches that can be replaced in seconds for troubleshooting, snap-out readout, wire-wound resistors, epoxy fiberglass circuit boards . . . measures AC or low-level DC with accessories. Price: $1,460.

784 DIGITAL OHMMETER—for precise measuring and logging at low cost . . . same high quality features as 484A . . . measures 0.1 ohm to 10 megs with accuracy of ±0.05% ± 1 digit (±0.1% of reading above 5 megs) . . . auto ranging and auto control for data logging. Price: $1,460.

MODELS 54, 54A, 55, 55A DIGITAL COMPARATORS—for go/no-go testing, plug these into any NLS instrument having printer connection . . . limits set by BCD coded voltages, contact closures, or front panel knobs . . . each limit can be on any range and of either + or − polarity . . . signals TOO HIGH, TOO LOW, or OK to recording and control devices. Price $2,035 to $2,935.

Tag Line: The blue tag indicates that these new models are NLS "off-the-shelf" instruments. Call your nearest NLS office to see demonstrators in action today or take delivery on your own instrument within 10-30 days. Prices are F.O.B. destination in U.S.A.

Originator of the Digital Voltmeter

non-linear systems, inc.

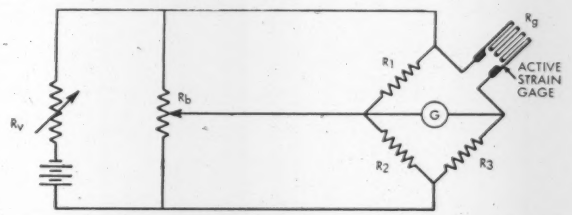
DEL MAR, CALIFORNIA

CIRCLE 26 ON READER-SERVICE CARD

BRIEFS

Strain Recording

Strain is a fundamental physical phenomenon . . . The terms "strain" and "physical deformation" are synonymous. In engineering, strain refers to the change in any linear dimension of a body which is due to the application of either internal or external forces . . .

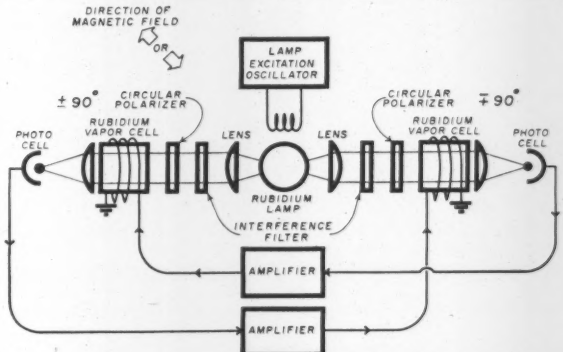


Strain gages are electromechanical transducers that are applied to the surface of the material. The strain gage exhibits a change of electrical resistance with a change in strain. The change is linear, and may be measured with suitable instrumentation. The method, although indirect, is precise . . . (*From new* 20-*page Form SR, Brush Instruments, Clevite Corp.,* 37*th* & *Perkins, Cleveland* 14, *Ohio.*)

FOR THIS LITERATURE CIRCLE 210 ON READER-SERVICE CARD

Space Magnetometers

Varian Associates developed the self-oscillating alkali vapor resonance magnetometer (using rubidium vapor) to extend magnetometer capabilities. This class of mag-

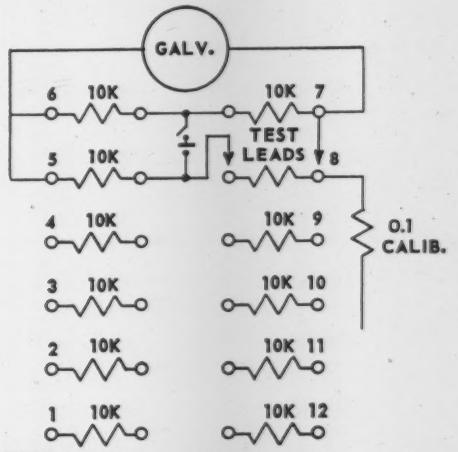


netometer exploits magnetic field-dependent energy levels in the atom of alkali metals, through a technique of optical monitoring . . . The output . . . is a field-dependent frequency, but its signal-to-noise ratio is independent of the measured field . . . Due to the Zeeman effect, the energy levels associated with the single valence electron of rubidium become split into various sublevels whose separations are dependent upon the intensity of the ambient magnetic field . . . An ingenious technique of optical pumping and monitoring was developed by Dehmelt to produce and detect this proportional splitting, making practical the sensitive and accurate magnetometers described herein . . . (*From new Geophysics Technical Memorandum No.* 8, *Instrument Div., Varian Associates, Palo Alto, Calif.*)

FOR THIS LITERATURE CIRCLE 211 ON READER-SERVICE CARD

Ratios to 0.1 PPM

In this issue we will expand the previous discussions by explaining how the DMR Series Resistance Sets can be used to check ratio accuracies with uncertainties of one part in ten million (0.00001%), and, concurrently, how the DMR Series may be used to verify the 0.0001% accuracy of the VDR-106 . . .



The DMR-105 Set permits series interconnections of its twelve Primary Standard Resistors to obtain 66 ratios. These ratios are defined by the fraction $r = k/n$ where n is the total number of input resistors in the string and k is the number (less than n) across which the output voltage is developed. Additional ratios may be obtained by parallel as well as series connection of resistors, but for the purpose of this paper we will confine ourselves to the simple series connections . . . The DMR-105 Set, comprises twelve 10,000 ohm primary standard resistors. In this resistance range the combined residual ratio error introduced by interconnection wiring and insulation leakage will be less than one part in 10,000,000 (for a series string of ten resistors) if resistance uncertainty is less than 0.01 ohms and leakage uncertainty is greater than 125,000 megohm . . . (*From new* 4-*page "JRL Precision," Vol. IV/No.* 1, *Julie Research Laboratories, Inc.,* 603 *W.* 130*th St., New York* 27, *N. Y.*)

FOR THIS LITERATURE CIRCLE 212 ON READER-SERVICE CARD

Pressure-To-D-C Transducer

Model DC-2000 Deeceeducer combines a variable-reluctance diaphragm-type pressure transducer with an all-silicon solid-state synchronous modulator-demodulator circuit to provide a complete in-line instrumentation module for the linear conversion of pressure to a proportional d-c voltage. The DEECEEDUCER is excited from an unregulated 28-volt d-c supply. A regulated transistorized multivibrator generates a square-wave drive to a variable reluctance bridge and a synchronous transistor demodulator. The bridge output is proportional to the pressure input and is demodulated and filtered to provide a highly linear zero-to-5 volt d-c output proportional to the full-scale pressure rating of the transducer. Pressure ranges extend from 5 to 5000 psi in gage, absolute and differential pressure types . . . (*From new* 2-*page bulletin, Solid State Electronics Co.,* 15321 *Rayen St., Sepulveda, Calif.*)

FOR THIS LITERATURE CIRCLE 213 ON READER-SERVICE CARD

CIRCLE 27 ON READER-SERVICE CARD——→

Son, we call this
a "Fisher"

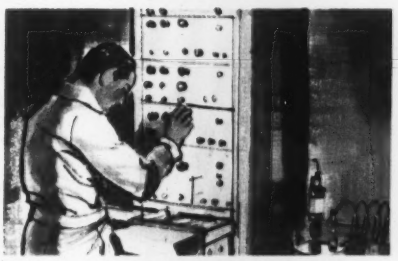
The worthiness of a name

In refineries, chemical plants, and oil fields, many "old timers" associate the name "Fisher" with high quality control valves and liquid level controllers. Through the years, in their work on instruments and controls, they have come to know that "Fisher" means dependability.

"Put a 'Fisher' in the line, and forget it." they would always say.

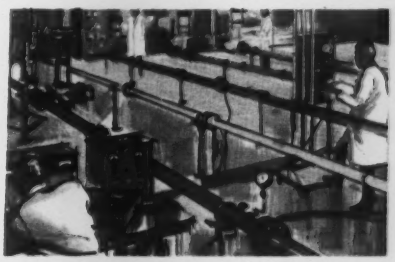
The quality found in Fisher equipment lies not only in metal and fiber and paint. It is also found in the practical design, manufacturing techniques, and the rigid inspection program. These high quality factors along with outstanding research and engineering facilities assure you of trouble-free performance. Throughout the world, "Fisher" means dependable control equipment.

FISHER GOVERNOR COMPANY *Marshalltown, Iowa / Woodstock, Ontario / Rochester, England*

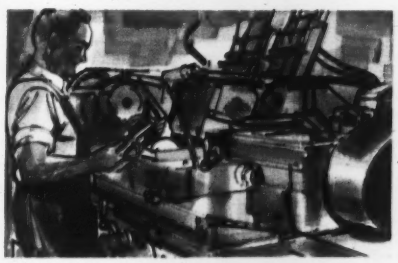


Continuous Advanced Research . . . Fisher research maintains a continuous program for development and use of new metals and materials to meet the increasingly severe conditions, encountered daily, in the nuclear and cryogenics fields.

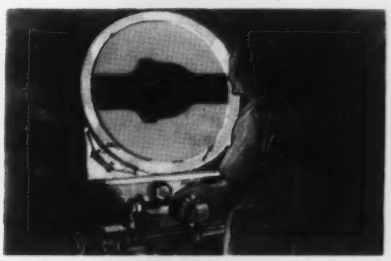
Engineering and Research . . . Almost three-fourths of Fisher's 41 graduate engineers have more than 10 years service . . . a total of 380 years experience in design engineering aimed at solving industry's flow control problems, practically and efficiently.



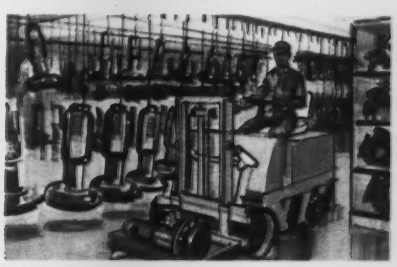
Testing and Development . . . Representative of the very latest and finest in equipment that aids Fisher engineers in the development of new and improved products is the recent addition of a test line that is capable of handling air or water pressures up to 2,500 psi.



Latest Production Methods . . . Various new style grinders produce a super-finish on Fisher valve guides and bushings, second to none in the industry. It is typical of precision manufacturing methods that assure long, trouble-free operation of Fisher controls.



Rigid Inspection Procedures . . . The highest ratio of inspection personnel to production personnel in the industry is maintained at Fisher. As an example, there are no less than 704 inspection operations on a 4" Type 657-A diaphragm control valve.



Efficient and Fast Service . . . "Supermarket" 36-hour delivery, from the factory, on popular sizes and types of controls is only one of many services available to Fisher customers. Seventeen sales offices throughout the country maintain field stocks for immediate delivery.

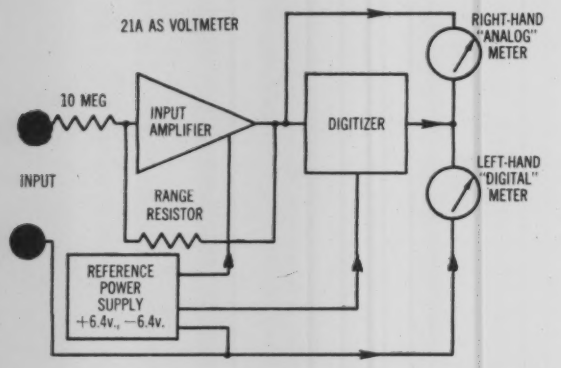
If it flows through pipe anywhere in the world ...chances are it's controlled by.....

FISHER® Controls

SINCE 1880

Semi-Digital Volt-Ohmmeter

The Type 21A Semi-Digital Volt-Ohmmeter is a general purpose measuring device combining the accuracy of a standards-lab instrument with the ruggedness and



versatility of an "everyday" multi-range meter . . . Two conventional D'Arsonval movements are used, so arranged that the "resolving power" of one acts to multiply the resolution and accuracy of the other. The result is accuracy corresponding approximately to three significant figures . . .

A signal voltage proportional to the unknown voltage or resistance is obtained from an input amplifier. This voltage (ranging from −6.4 to +6.4 volts) is applied to a binary digitizing circuit that produces a nearly equal voltage quantized in 32 very accurate steps of 0.2 volt each. The right-hand meter is fed from the quantized voltage so that it moves in discrete steps, forming a digital indicator. The second (right-hand) meter indicates the difference between the signal voltage and quantized voltage. It thus interpolates between the steps of the first meter. The sum of the readings of the two meters indicates the value of the unknown . . . (*From new 4-page brochure, J-Omega Co., 323 First St., Los Altos, Calif.*)

FOR THIS LITERATURE CIRCLE 214 ON READER-SERVICE CARD

Measurement Engineering

TEMPE, ARIZ.—"How to Obtain Valid Data on Purpose" is the theme for the new short courses on Measurement Engineering to be offered at Arizona State University, January 29 to February 2, 1962.

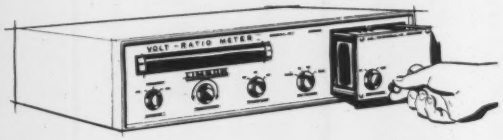
The short courses consist of a lecture program and a concurrent experimental program. About one half of the lectures concentrate on the basic physical principles on which transducers are based and on fundamental measurement theory (including static and dynamic system behavior and the correlation between them). Particular emphasis is placed on the interaction between system components and on how measurement systems are properly planned and designed. The other half of the program is devoted to measurement problems and approaches in specific areas.

Registration lists close on January 19, 1962. Contact Prof. Peter K. Stein, Engineering Center, Arizona State University, Tempe, Arizona, the Director for the Short Courses, for further information. Fees for the programs are $200 for the lecture program and $125 for the experimental program.

FOR THIS LITERATURE CIRCLE 215 ON READER-SERVICE CARD

Digital Voltmeters and Volt-Ratio Meters

A unique arrangement is used for mounting the precision potentiometer resistors. Vibrations from stepping switches often cause resistor leads or solder joints to fail. By press fitting each resistor into a solid mounting block,

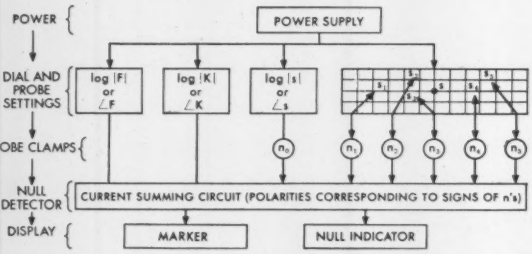


which in turn is fastened with the stepping switch to a floating swivel bracket, conflicting vibrations are eliminated. Also, to improve potentiometer linearity, only one solder junction appears between each resistor and its connection to the switch . . . Precision potentiometer resistors and stepping switches swing out so that trouble shooting and adjustment are done without difficulty. Readout tubes can be replaced in seconds by simply removing the readout bezel. Circuitry is all-transistorized, and complete sections such as amplifiers, switch drivers, reference, and power supplies, are mounted on plug-in cards to reduce down time if repairs become necessary . . . (*From new 4-page bulletin Cimron Corp., 1162 Morena Blvd., San Diego 10, Calif.*)

FOR THIS LITERATURE CIRCLE 216 ON READER-SERVICE CARD

Algebraic Computer

The Model 10 ESIAC Algebraic Computer calculates solutions for the characteristic equations of circuits and control systems. The results are presented as root-locus plots and Bode phase and gain diagrams . . . The theory of the computer is best explained by taking the original equations and separating the real and imaginary parts into a pair of equations . . .



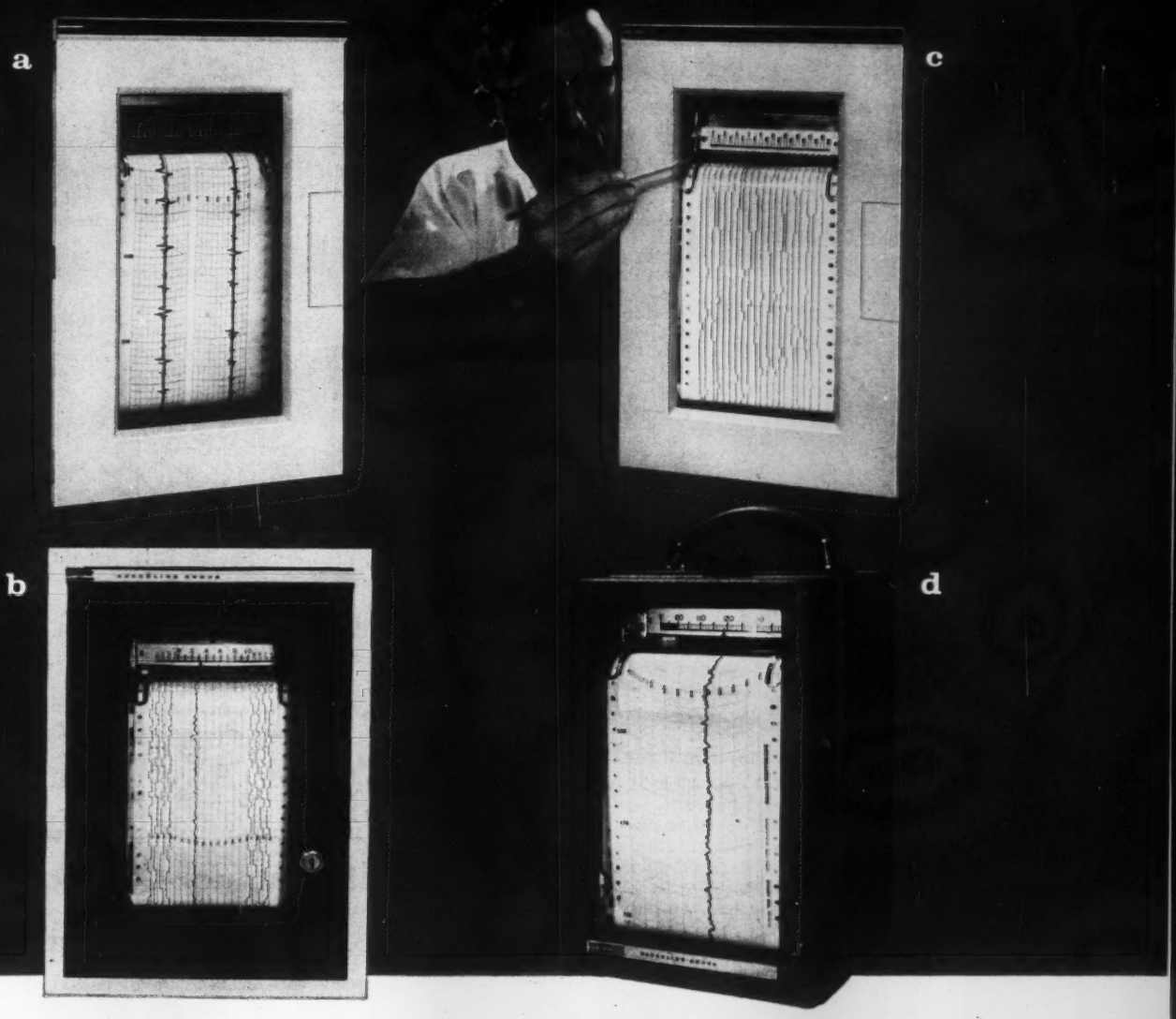
The basic principles of ESIAC are outlined in the block diagram . . . The grid of intersecting lines represents a system the coordinates of which are the log magnitude and the angle of a complex variable which will be called s. The values of the s_is in the equation are points in this coordinate system. These currents are then added algebraically with polarities corresponding to the sign of n in each term. When the currents are exactly balanced, as shown by a null indicator, the equation is satisfied . . . (*From new 4-page Catalog Sheet C-20, Electro Scientific Industries, Inc.—formerly Electro-Measurements, Inc.—7524 S. W. Macadam Ave., Portland 19, Ore.*)

FOR THIS LITERATURE CIRCLE 217 ON READER-SERVICE CARD

(*Continued on page* 1798)

CIRCLE 27 ON READER-SERVICE CARD

CIRCLE 28 ON READER-SERVICE CARD



Available in portable, wall, flush and projection mounting switchboard cases.

NEW Instrument Designs, Applications from Esterline Angus

a New "602" Two-channel Recorder • Simultaneously records two variants on adjacent 2″-sections of single 6″-wide chart. Applications: checking current and voltage, quality determination of arc welds, records of input vs. output.

b New Analog-Event Recorder • One instrument does the work of two . . . simultaneously records analog data and up to 8 channels of event information on single 6″-wide chart. Applications: wind speed and direction, substation bus voltage and breaker operation, rate of production (speed) and conveyor operation.

c New "620" Event Recorder with Tempen • Writes without ink, using electrically-heated styluses. Simultaneously records "when," "how long" and "how many" on as many as 20 channels. Applications: productive and nonproductive time of any or all machines in a plant, circuit breaker action, qualitative analysis, missile performance.

d New Expanded Scale Voltmeter • Provides increased readability of voltage records as upper ¼ of voltage range is expanded to fill upper 80% of chart span. Applications: checking voltage regulation, voltage records, trouble-shooting.

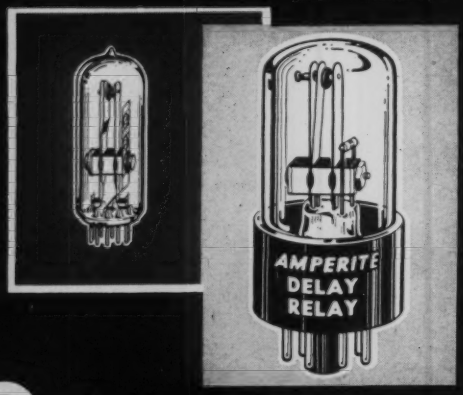
Standing solidly behind the creative designs of our engineering staff are the highly-developed skill and attention to detail of our master craftsmen. At right, M. R. Felske, Master Craftsman at Esterline Angus for 34 years. *For more detailed information on any instrument or its applications, write:* ESTERLINE ANGUS INSTRUMENT COMPANY, INC., Box 596-N, Indianapolis 6, Indiana.

Excellence in graphic recording for over 50 years—ESTERLINE ANGUS

Makers of instruments to record: MICROAMPERES, DC · MILLIAMPERES, DC · AMPERES, AC AND DC · VOLTS, AC AND DC · WATTS, AC AND DC KVA, KVAR · VOLTAGE TRANSIENTS, AC · FREQUENCY · POWER FACTOR · EVENTS · SPEED · POSITION · MOTION · PRESSURE · VACUUM

AMPERITE

Thermostatic DELAY RELAYS



Only a glass seal

offers true hermetic sealing

. . assuring maximum stability and life!

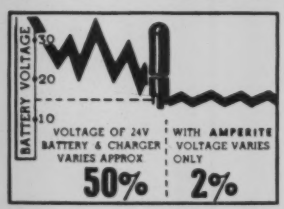
Delays: 2 to 180 seconds . . . Actuated by a heater, they operate on A.C., D.C., or Pulsating Current . . . Being **hermetically sealed,** they are not affected by altitude, moisture, or climate changes . . . **SPST only**—normally open or normally closed . . . Compensated for ambient temperature changes from —55° to +80° C. . . . Heaters consume approximately 2 W. and may be operated continuously . . . The units are **rugged, explosion-proof, long-lived,** and—**inexpensive!**

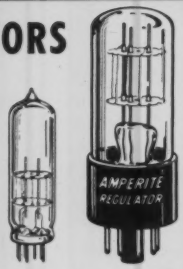
TYPES: Standard Radio Octal, and 9-Pin Miniature . . . **List Price, $4.00.** Also — **Amperite Differential Relays:** Used for automatic overload, under-voltage or under-current protection.

PROBLEM? Send for Bulletin No. TR-81

AMPERITE

BALLAST REGULATORS





Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—50° to +70° C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . . **List Price, $3.00.**

Write for 4-page Technical Bulletin No. AB-51

AMPERITE

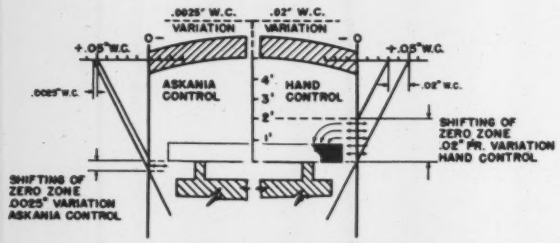
561 Broadway, New York 12, N. Y. . . . CAnal 6-1446

In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

CIRCLE 29 ON READER-SERVICE CARD

Furnace Control Systems

In the processing of metals from the time the ore leaves the ground, heat plays a most important part . . . Regardless of the style of furnace or the working requirements, there are several basic factors which govern satisfactory heating in all furnaces. These basic factors are each controlled by a sub-system as furnace pressure, heat input (fuel or air flow), fuel-air ratio, reversal, multiple fuel firing, and temperature . . .

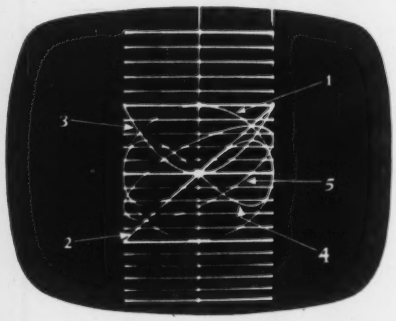


It cannot be stressed too strongly that extremely close tolerances are absolutely essential in the regulation of furnace pressure. For instance, a variation of 0.005 inch W. C. can determine the difference between proper and improper heating . . . many GPE controlled installations are holding furnace pressure within the limits of plus or minus 0.0025" W. C. Figure shows a comparison of manual control versus GPE control . . . (*From new 24-page catalog of industrial heating furnace control systems "Folio* 122," *GPE Controls, Inc.,* 240 *E. Ontario St., Chicago* 11, *Ill.*)

FOR THIS LITERATURE CIRCLE 218 ON READER-SERVICE CARD

Multi-Channel Calibrated Display System

The 5934 Display System measures and displays complex phenomena with accuracies comparable to conventional X-Y chart recorders, but at speeds typical of large screen oscilloscopes . . . Presented on the cathode ray



tube is the simultaneous display of the outputs of eight separate integrators . . . The multi-channel input capability of the 5934 Display System permits simultaneous display of seven phase relationships in the cross plot mode as well. Here are shown the following phase plots: (1) Sine-cosine wave oscillator. (2) Sine vs sine. (3) Sine^2 vs sine. (4) Product of sine and cosine vs sine. (5) Output of first order filter vs sine wave input . . . (*From new* 12-*page Display System booklet George A. Philbrick Researches, Inc.,* 127 *Clarendon St., Boston* 16, *Mass.*)

FOR THIS LITERATURE CIRCLE 219 ON READER-SERVICE CARD

(*Continued on page* 1800)

CIRCLE 30 ON READER-SERVICE CARD

Fischer & Porter's

NEW IN-LINE BLENDING SYSTEMS

MIX FLUIDS RIGHT IN A PIPELINE

Eliminate batch mixing, holding tanks, trimming

Control total quantity ratios by an electronic "memory"

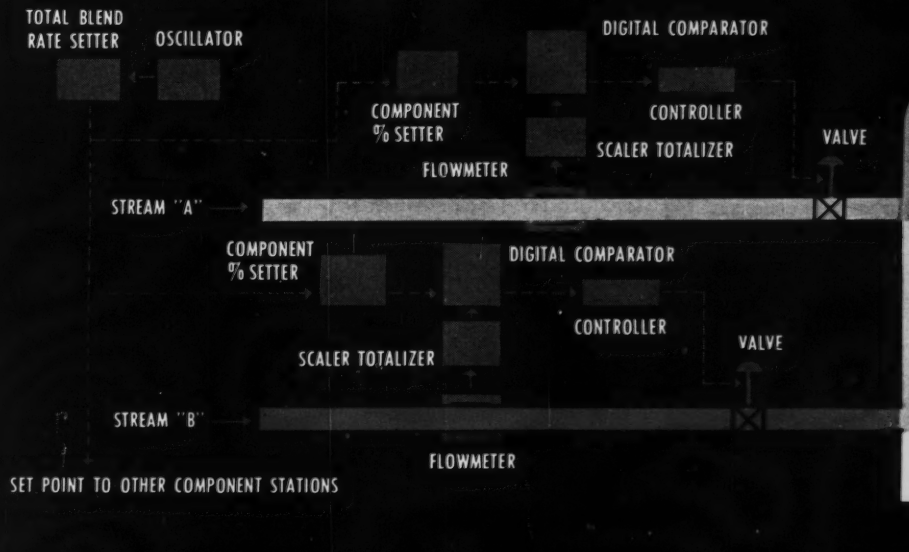
Give a system accuracy of better than ±½%

These new electronic In-Line Blending Systems let you blend two or more fluids — automatically and continuously in a pipeline — with greater accuracy than ever before. Each system combines flowmeters, interchangeable transistorised readout devices and electronic control units to give you a complete, packaged, blending facility from a single source — Fischer & Porter Company.

Each of these unique systems has a memory — that is, it "remembers" how much of any one ingredient has been added to the main stream. Then it goes on to compensate, continuously, for any deviations from the required total blend ratio, whether plus or minus, with an accuracy better than ±0.5%, a repeatability better than ±0.2%. And it is this memory characteristic which obsoletes older flow rate ratio methods.

Result: fast, precise, flexible systems that enable you to control mixing or blending from feed lines to point-of-use — product pipelines, tankers, whatever. You eliminate wasteful batching operations in between. Many types of systems are available, including the blending of two or more streams for petroleum, chemical, food, or other products of processing industries.

A description of your interests will bring you complete technical data. And, let us know if you would like to see a typical system in operation here at the plant . . . Fischer & Porter Company, 401 County Line Rd., Warminster, Pa. In Canada, write Fischer & Porter (Canada) Ltd., 2808 Jane St., Toronto.



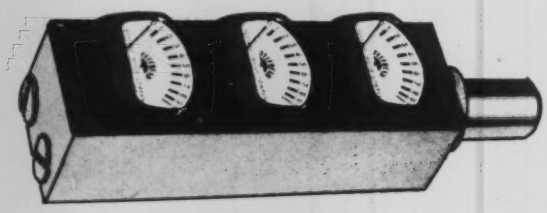
Typical multi-stream In-Line Blending System. All systems are electronic with measurement, control, and readout functions handled by interchangeable modules.

FP FISCHER & PORTER COMPANY

A world-wide Instrument Company with plants in Australia, Canada, England, France, Germany, Holland, Mexico, and the United States.

Remote Meter-Reading System

The American Meter with Teleread register has a round reading register mounted on the meter body. On the shafts of this register which indicates gallonage, are mounted precision-built potentiometers. These are wired through a flexible water-proof and vermin-proof cable to a plug located on the outside of the house and mounted in a shielded enclosure.

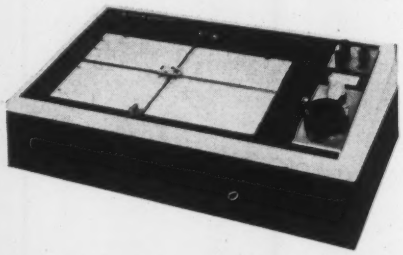


To read the meter from outside the house, the meter-reader carriers with him a compact light-weight readout mechanism which is about the size and weight of a flash-light. The end of this is inserted into the plug on the outside of the house. Current from the semi-permanent battery in the readout unit travels through the cable to the potentiometers, causing the position of the dial hands on the meter to be indicated on scales located on the readout unit. After noting the meter reading, the readout is removed from the outlet and the indications on the readout scales return to zero . . . (*From Bulletin 61A, Buffalo Meter Co., Inc., 2917 Main St., Buffalo 14, N. Y.*)

FOR THIS LITERATURE CIRCLE 220 ON READER-SERVICE CARD

T-Y Moving Pen Recorders

A new concept featuring maximum convenience in recording any variable as a function of time, . . . the T-Y recorder is designed to replace conventional self-balancing

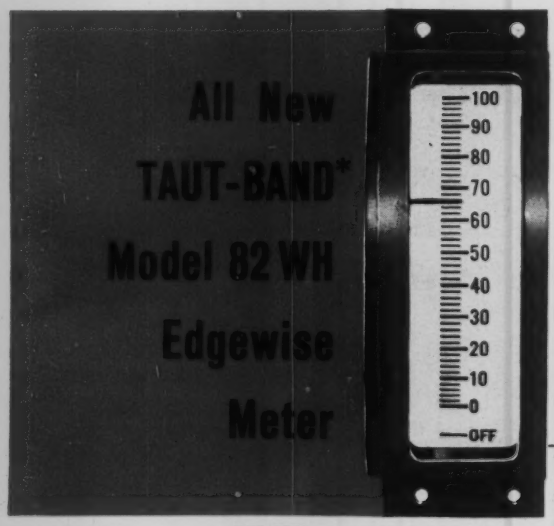


strip chart or circular chart recorders in any laboratory or industrial application where a total chart length of either 10″ or 15″ will provide adequate resolution. Records from the T-Y recorder are immediately available for use or reproduction and will fit standard laboratory notebooks or files . . . The T-Y recorder operates from low level DC signals. Converters are available from Houston Instrument for handling AC signals over a wide range of levels and frequencies and for logarithmic conversion of AC or DC signals over a 70 DB range. Another converter provides log discrimination for use in plotting log frequency over 1 to 3 or more decades . . . (*From new 4-page brochure describing Models HR-80 and HR-87 "T-Y" recorders, Houston Instruments Corp., Box 22234, Houston 27, Tex.*)

FOR THIS LITERATURE CIRCLE 221 ON READER-SERVICE CARD

(*Continued on page* 1804)

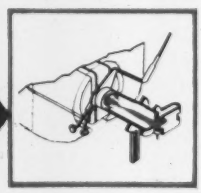
DESIGN IDEA
FOR INSTRUMENTATION...



Ideal for military and rugged commercial applications—requires small panel space but provides long, 2.7″, scale length. Ruggedly built with die cast zinc case.

Features the famous Hickok TAUT-BAND* friction free movement with ± 2% accuracy, standard.

See your Hickok Representative for more details or write for free data sheet.



*The Hickok TAUT-BAND Movement

THE HICKOK ELECTRICAL INSTRUMENT CO.
10519 Dupont Avenue, Cleveland 8, Ohio

CIRCLE 31 ON READER-SERVICE CARD

CHECKUP on your Control Valves... CHECKOFF these Annin Advantages*

*Any other source might give you a few... but with Annin you get them all!

MINIMUM number of parts per complete valve.

OVER 60,000 successful case histories of split body valve applications.

POSITIONING ACCURACY guaranteed, .001 inch per inch of stroke.

CONSTANT INSTRUMENT signal sensitivity throughout signal range.

COMPLETE INTERCHANGEABILITY of any Domotor valve to on-off pneumatic control, pneumatic hydraulic, electro hydraulic, electro pneumatic or manual actuator.

ENGINEERED FOR MANUAL control with any of the above automatic actuators, if desired, at minimum cost.

SIMPLIFIED ADDITION of high speed booster units to any pneumatic positioning actuator.

ADAPTABILITY of bellows seal, doolseal or plain extension to any standard valve.

BODY SIZES from ¼" up.

COMPLETE LINE of body ratings: 600—1500—2500 lbs. ASA; special 10,000 and 60,000 psig design, temp. —450°F to 1600°F.

CONVERSION FROM globe body to angle body construction with only one additional part.

ADAPTABILITY TO 3-WAY Valve Construction with minimum parts and cost.

MINIMUM COST for change from soft seat construction to hard seat, or vice versa.

First in a series of checklists on Annin features.

Annin **VALVES**

THE ANNIN COMPANY
1040 South Vail Avenue
Montebello, California

CIRCLE 32 ON READER-SERVICE CARD

Tomorrow's tubing technology—today

For uniform deflection from spring to spring use Superior Ni-Span C Bourdon tubing

Superior Ni-Span C* tubing possesses many of the attributes of an ideal Bourdon spring material. It is relatively easy to form by coldworking and can be heat treated after forming to obtain optimum operating characteristics. It can be readily joined by soft soldering, silver soldering or welding. It has high stability in a useful temperature range of —50 to 150°F, good creep resistance, low hysteresis, and excellent fatigue life. And it is uniform from tube to tube—free of inclusions and seams, carburization or decarburization, rough or corroded surfaces, and variations in wall thickness.

Superior Ni-Span C tubing is available in sizes from .010 to ⅝ in. OD x .125 in. wall maximum and from ⅝ to 1⅛ in. OD in wall thicknesses from .010 in. to .035 in. It can be furnished round and in Bourdon shapes such as elliptical, flat oval and "D" shaped to your specifications. Data Memorandum No. 19 gives complete details. Write for your copy today. Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

*Reg. TM International Nickel Co.

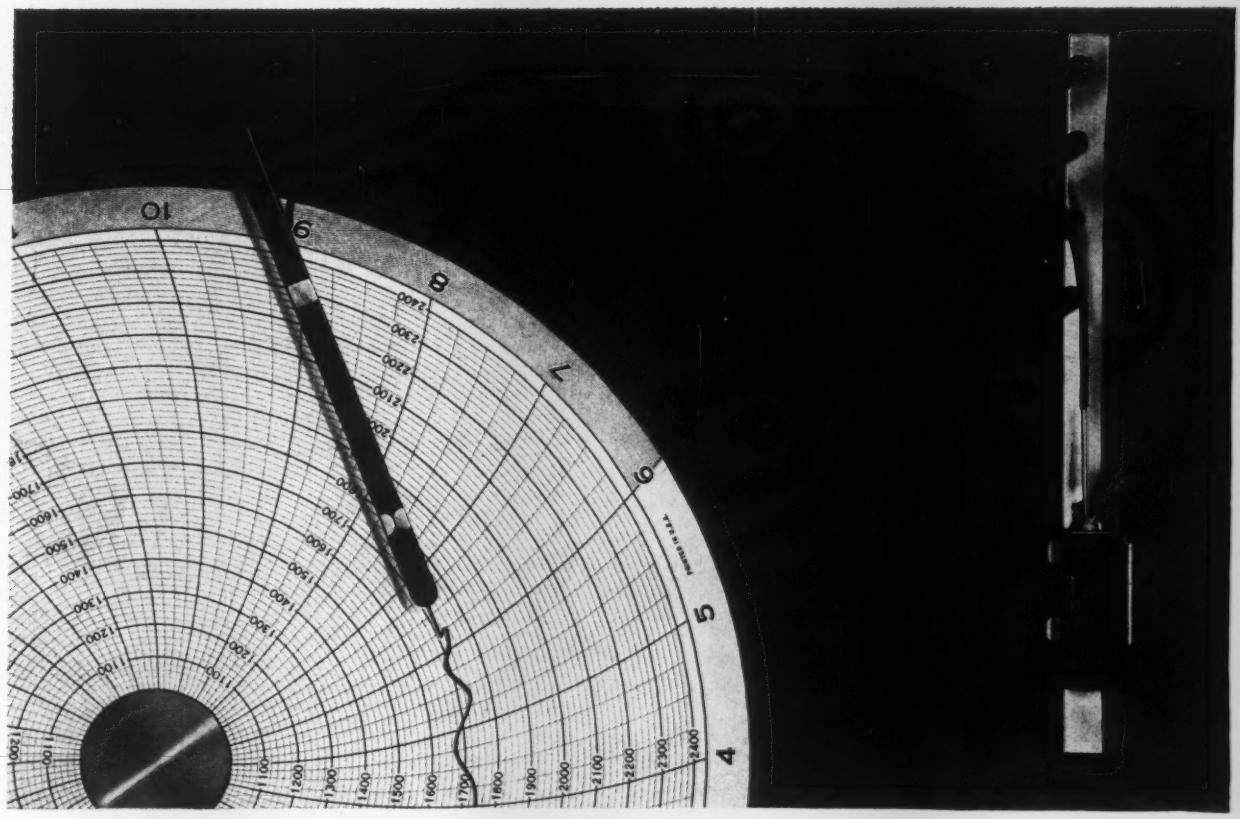
Superior Tube ST

The big name in small tubing

NORRISTOWN, PA.

West Coast: Pacific Tube Company, Los Angeles, California

CIRCLE 33 ON READER-SERVICE CARD



Esterbrook®

NEW MARK-TROL*

eliminates 95% of the mess and maintenance of round chart recorder inking systems . . .

In 10 minutes, convert present markers with Mark-Trol, a completely sealed capillary system with replaceable ink cartridge . . . adaptable to 90% of all round chart recorders in service today.

Esterbrook's Mark-Trol is a completely new concept in marking systems. Because of its universal design, you can eliminate the messy problems inherent in most round chart inking systems in use today. Because maintenance is reduced to little more than routine inspection, Mark-Trol will pay for itself in a matter of days.

Sealed system eliminates dust, dirt, moisture and mold which clogs open-bucket devices. Operation is thoroughly efficient regardless of location, inside or out, under service conditions of humidity, precipitation, chemical fumes or other foreign matter, and over a wider temperature range —0°F to 145°F. Slip-in, disposable, sealed ink cartridge means ink is never directly handled . . . no messy suction tubes, syringes, droppers; no reservoirs to clean out. Eliminates breakage of plastic bags or glass devices. The cartridge contains a large supply of ink, extending your change cycle from days to months . . . and then in a matter of seconds the cartridge is replaced.

ORDER ONE FOR TRIAL—Mark-Trol has been field-tested for 2½ years—extensively in the power and processing fields. We invite you, however, to make a trial installation of your own with a Mark-Trol unit. Send us the coupon today.

Authorized Distributor:

Technical Recording Chart Division
Graphic Controls Corporation
189 Van Rensselaer St., Buffalo 10, New York

Please send us..... Mark-Trol Conversion Kits at $12.00 each.

Name..... Title.....

Company.....

Address.....

Please also send literature completely describing Mark-Trol. ☐

*Trademark

MARK-TROL **THE ESTERBROOK PEN COMPANY** • Technical Products and Instruments Division

CIRCLE 34 ON READER-SERVICE CARD

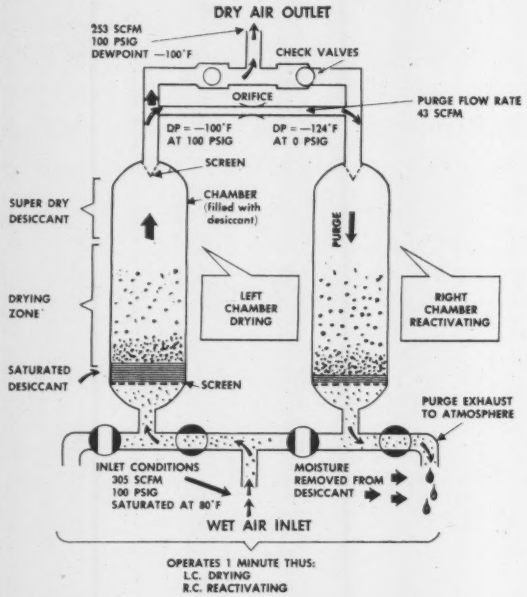
INSTRUMENT ACCURACY (± ½ PERCENT)
EXPLOSION PROOF
PRESSURE SWITCH
DESIGNED TO OIL INDUSTRY SPECS

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	LINKAGES & BEARINGS which, as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements	LIQUID SWITCHING ELEMENTS which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	ACCORDION BELLOWS which make the pressure switch sensitive to vibration.

PRESSURE SWITCH DIVISION
ASK FOR HANDBOOK & CATALOG 61-62
Barksdale valves
5125 Alcoa Avenue, Los Angeles 58, California
CIRCLE 35 ON READER-SERVICE CARD

"Heat-Less" Dryers

Heat-Les Dryers utilize the natural tendency of desiccants to come into equilibrium with their surroundings. During the drying cycle, the desiccant adsorbs moisture



from the incoming gas stream. During the reactivation cycle, a small portion of the super-dry gas is passed over the desiccant at atmospheric pressure, creating an environment in which the desiccant must give up the previously adsorbed moisture to reach equilibrium . . . The diagram shows the wet gas entering at the bottom of the left-hand chamber, passing upward through the desiccant where it is dried to an extremely low dewpoint. The dry air passes through the check valve to the dry air outlet. Simultaneously, a small percentage of the dry gas is expanded through the orifice between the chambers, and flows down through the right-hand chamber, reactivating the desiccant, and passing out through the purge exhaust. At the end of the cycle, the chambers are automatically reversed . . . (*From new 6-page Bulletin HA-308, Trinity Equipment Corp., Cortland, N. Y.*)

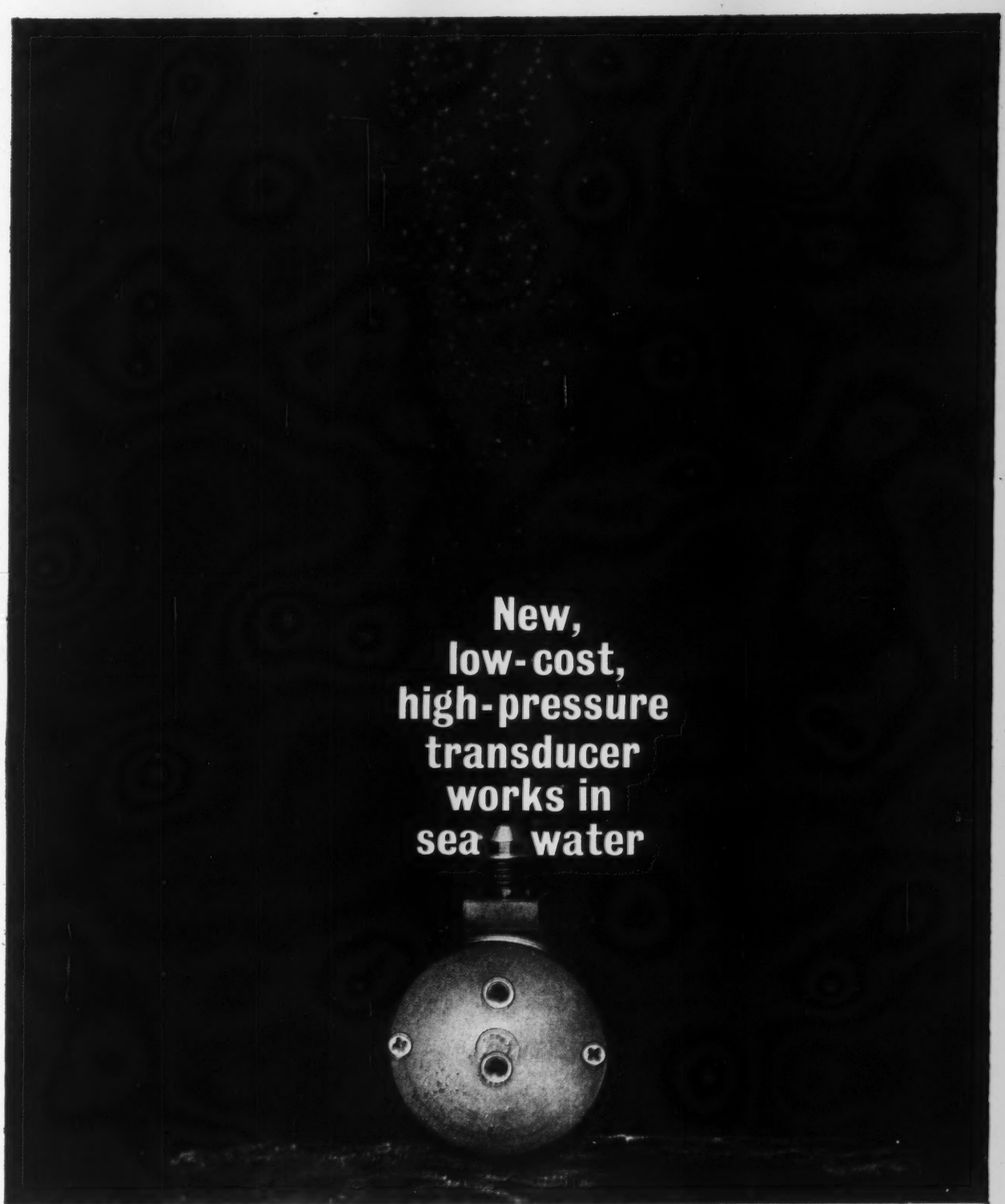
FOR THIS LITERATURE CIRCLE 222 ON READER-SERVICE CARD

Solenoid Valves Feature Packless Construction

Series 90, 2-Way Solenoid Valves are designed in Normally-Open and Normally-Closed types with Brass and Stainless Steel bodies. Orifice sizes range from 1/32" to ⅛". Choose from ⅛" and ¼" pipe sizes or JIC tube connections. Differential pressure ratings go as high as 2000 psi. Optional features, available for all models, include a choice of coils, coil housings (including explosion-proof and watertight designs), mounting brackets and corrosion-resistant trim . . . (*From new 4-page Bulletin SV 559, Hoke Incorporated, 1 Tenakill Park, Cresskill, N. J.*)

FOR THIS LITERATURE CIRCLE 223 ON READER-SERVICE CARD

(*Continued on page* 1807)



A unique "Z"-flexure® amplification makes DeJUR's new HPT-10 miniature high-pressure transducer the lightest, smallest, most-economical precision measuring instrument of its type anywhere. A simplified, frictionless mechanism, the "Z"-flexure eliminates the need for bearings, pivots, rubbing-point linkages and other devices which adversely affect reliability. This new design—which is continuously operable in sea water and other corrosive and non-corrosive media—also achieves remarkable dynamic balance and accuracy in harsh temperature, vibration and acceleration environments. For immediate delivery (at low cost) in production quantities, and for complete details, write today to Instruments Division, DeJUR-Amsco Corporation, Northern Boulevard at 45th Street, Long Island City 1, New York.

YOU'RE ALWAYS SURE WITH DeJUR ELECTRONIC COMPONENTS

Manufacturers of precision electronic equipment for over 35 years

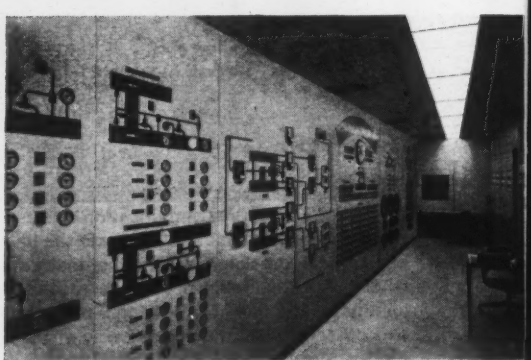
CIRCLE 36 ON READER-SERVICE CARD

The Most Significant Picture in Our Industry

Every control systems engineer with an eye on the future has his eye on this building.

This is a picture of the Thomas J. Watson Research Center, dedicated on April 25, 1961, at Yorktown, New York. It is the largest laboratory in the world devoted entirely to computer research. Within this building, IBM scientists are engaged in basic and applied research which will result in new products for IBM, and new potentials for computer applications.

These potentials are what excite control engineers. We see control systems of the future coming closer to achievement—we are stimulated to turn the designs of our day dreams into designs with possibilities. We know, that in the years to come, the work done in this building will revolutionize our industry. As a leader in control system design and manufacture, Electro-Mech welcomes this research center as a link to the future. We are proud that one of our custom products, the graphic control panel shown at right, is a part of this significant new building.

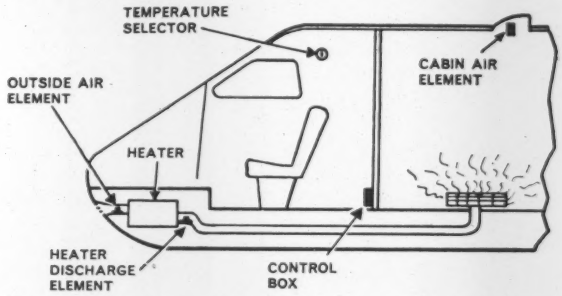


Electro-Mech Corporation Electro-Mech® **Norwood, New Jersey**

A SUBSIDIARY OF AMERICAN CHAIN & CABLE COMPANY, INC. ACCO

Aircraft Temperature Control

The one big difference between house heating and aircraft heating is the introduction of a third element . . . Both systems have one element located in the heater and a second element located in the cabin or room, but the aircraft has a third element that detects outside air temperature . . . An aircraft external temperature can drop 50 degrees or more on just a few minutes after take-off. Just a few thousand feet in altitude can mean a great change in temperature . . .

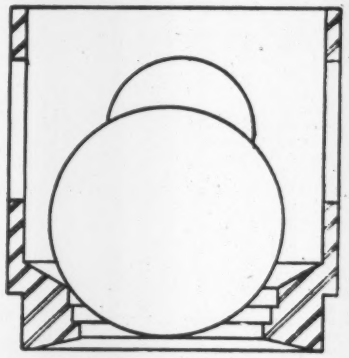


There are two basic heating systems used in business aircraft. A heater cycling system uses a gasoline fired aircraft heater. A proportioning system uses a heat exchanger that draws warm air from the engine exhaust and mixes it with cold air to the desired temperature. In the heater cycling system, a relay turns on, or shuts off, the aircraft heater as required to maintain a constant temperature in the cabin. In the proportioning system, an actuator and valve assembly is used to mix the correct proportion of hot and cold air to maintain the desired temperature. Both systems use a control box three elements, and a temperature selector . . . (*From new* 8-*page booklet "The Case of the Missing Element," Aircraft and Missile Products Div., Barber-Colman Co., Rockford, Ill.*)

FOR THIS LITERATURE CIRCLE 224 ON READER-SERVICE CARD

E-Z Clean Liquid End Pump

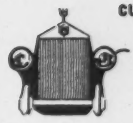
Series 300 controlled capacity pumps . . . have interchangeable liquid ends, available in a large variety of corrosion resistant materials (which) are easily inter-



changed in the field. The exclusive American design allows the liquid end to be rotated in the body thus simplifying piping installation . . . (*From* 12-*page Catalog* 300, *"Series* 300 *Controlled Capacity Pumps," American Meter Co., Pump Div.,* 13500 *Philmont Ave., Phila.* 16, *Pa.*)

FOR THIS LITERATURE CIRCLE 225 ON READER-SERVICE CARD

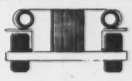
(*Continued on page* 1812)



CUSTOM-BUILT AS A LIMOUSINE: Each ALPA Camera is literally made to your order, with all the skill and experience of Swiss Master Craftsmen.

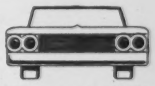
CONVENIENT AS A FAMILY CAR: Fingertip controls, built-in exposure meter and large brilliant groundglass image—for practically automatic through-the-lens framing, focusing and depth-of-field control.

VERSATILE AS A JEEP:



10 Automatic Diaphragm lenses from 24mm to 180mm (other lenses up to 5000mm) PLUS a continuous focusing range from infinity down to ultra close-ups and photomicrography, **without gap.**

COLORFUL AS A CONVERTIBLE: 5 APOCHROMATS—Switar and Macro-Switar 50mm f/1.8, Kinoptik 75mm f/2, 100mm f/2 and 150mm f/2.8—offer exclusive correction of all 3 primary colors.



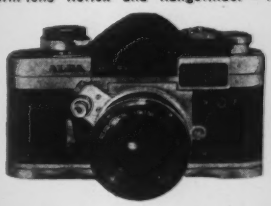
FAST AS A RACING CAR: 1:1 LIFESIZE image, straight 0° viewing, split-image rangefinder, lightning reflex mirror, hair-trigger release, quick-change lenses w/Automatic Diaphragms, rapid-wind lever and high-speed rewind crank with parallelogram.

SHARP AS A SPORTSCAR: Each ALPA lens is individually film-tested for critical sharpness, perfect tonal contrast and brilliant overall illumination.

STURDY AS A TRUCK: Rugged Swiss precision mechanism withstands extreme wear, temperatures and shock, limiting repairs to an absolute minimum.

COMPACT AS A SMALL-SIZE CAR: Lightweight (1½ lbs.) and compact (5¾" x 3¾" x 2"), ALPA combines all the features of the THREE most advanced camera types—Single-lens Reflex, Twin-lens Reflex and Rangefinder—in ONE camera . . .

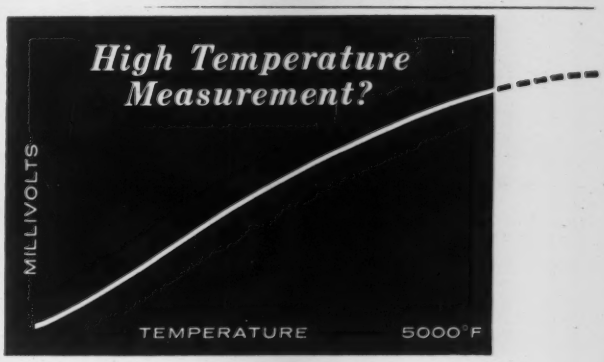
THE NEW ALPA 6c ALL-IN-ONE 35mm CAMERA



karl heitz Inc. **480 LEXINGTON AVE., NEW YORK 17 • YUkon 6-4920**

Please write for free illus. brochure ICA-10 or see your franchised ALPA dealer.

CIRCLE 38 ON READER-SERVICE CARD



The need grows daily and scientists and engineers with ever-increasing frequency "ask Pyro". Long ago, Pyro Electric, Inc. enlarged its research, engineering and facilities for designing and producing sheathed thermocouples and conductors for high temperature service. New alloys, new insulation—new heights have been reached, others show great promise. Breakthroughs have been made in fabricating the noble, exotic and refractory metals.

We will be pleased to send you our latest thermocouple Output-Temperature curves along with the types of insulating materials and protective tubing that can be used up to 5000°F.

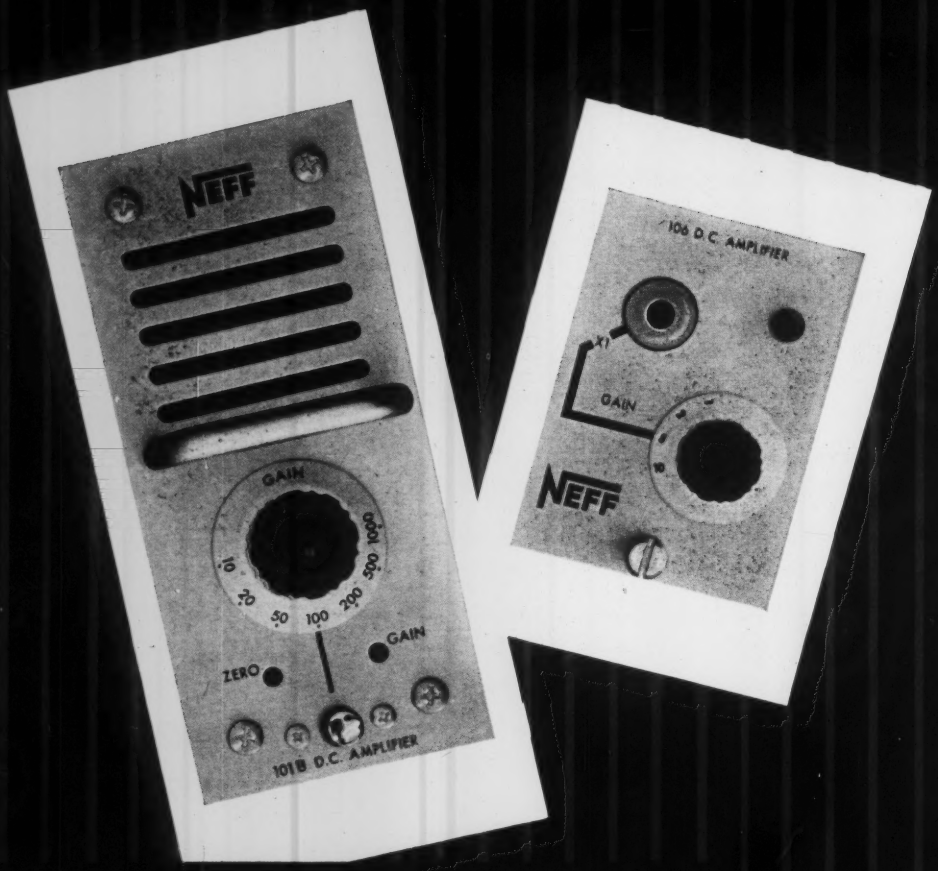
"Ask Pyro" for any standard or special thermocouple or conductor needs. Pyro Electric, Inc., Walkerton, Indiana.

Thermocouples • Sheathed Conductors • Assemblies

PYRO electric inc.

CIRCLE 39 ON READER-SERVICE CARD

← **CIRCLE 37 ON READER-SERVICE CARD**



NEFF INSTRUMENT CORPORATION, WITH MANY PROVEN CONTRIBUTIONS TO INSTRUMENTATION, INVITES YOUR INSPECTION AND EVALUATION OF THESE RECENTLY INTRODUCED AMPLIFIERS. THEY HAVE BEEN DESIGNED TO SATISFY TODAY'S MORE CRITICAL APPLICATIONS. NEFF CUSTOMERS KNOW THAT EACH AMPLIFIER WILL MEET ITS PUBLISHED SPECIFICATIONS. FOR *YOUR* CRITICAL AMPLIFIER APPLICATIONS — LOOK TO NEFF.

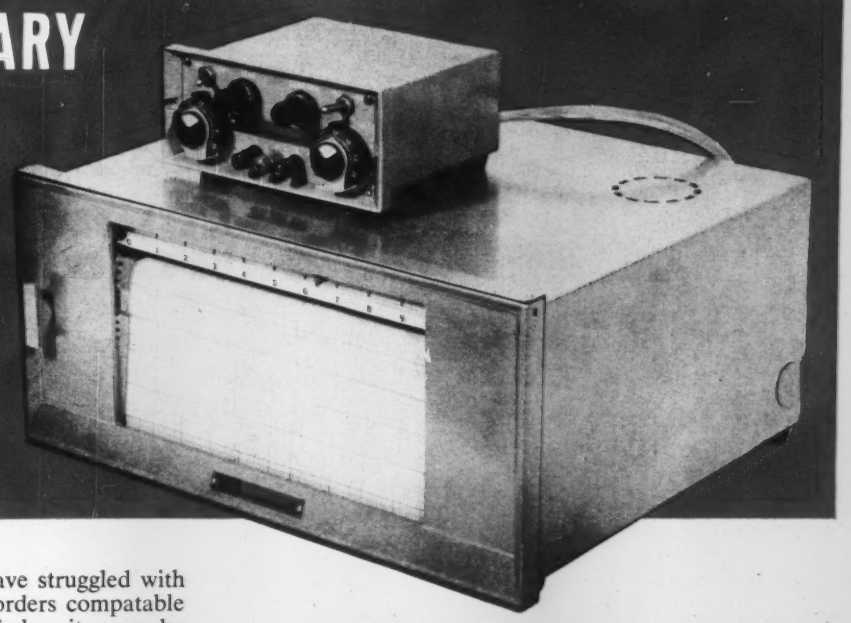
NEFF
INSTRUMENT CORPORATION
1088 East Hamilton Road Duarte, California

TYPE 101B AN EXTREMELY RELIABLE SOLID STATE DIFFERENTIAL DC AMPLIFIER COMBINING HIGH GAIN, LOW NOISE, HIGH INPUT IMPEDANCE AND LOW OUTPUT IMPEDANCE WITH INTERCHANGEABLE PLUG-IN FILTERS. THIS AMPLIFIER IS IDEAL FOR NARROW BAND REQUIREMENTS WHERE NOISE OR GROUND CURRENTS CREATE PROBLEMS.

TYPE 106 A SOLID STATE BROAD BAND, SINGLE ENDED LOW GAIN DC AMPLIFIER PARTICULARLY APPLICABLE AS A GALVANOMETER DRIVER OR LINE DRIVER. THE AMPLIFIER FEATURES HIGH OUTPUT CURRENT, LOW OUTPUT IMPEDANCE, AND OPTIMUM ISOLATION. A DUAL OUTPUT IS PROVIDED — DIRECT OR THROUGH A PLUG-IN DAMPING NETWORK WHICH ACCOMMODATES THE RESISTANCE NECESSARY TO MATCH ANY GALVANOMETER.

CIRCLE 40 ON READER-SERVICE CARD

REVOLUTIONARY NEW CONCEPT IN RECORDING!



For years instrument users have struggled with making their potentiometer recorders compatable with changing input needs. Today it may be necessary to measure temperature, tomorrow pressure. In order to be prepared to meet these changing demands it has been necessary to stock a number of recorders, or spend hours in modifying existing input circuits.

This costly and outmoded instrumentation is no longer necessary! Westronics, Inc. now brings to the industry a totally new *UNIVERSAL RECORDER* featuring panel or table mounted *EXTERNAL PLUG-IN* input modules. Each has in itself a maximum of versatility.

The Standard Universal Recorder is completely self contained: Ready for millivolt or thermocouple recording (changeable by means of *INTERNAL PLUG-IN RANGE CARDS).*

By simply connecting one of the *EXTERNAL INPUT MODULES* to an existing receptacle on the rear of the instrument, its uses are extended to: *ADJUSTABLE SPAN AND ZERO, RESISTANCE BULB CALIBRATION, STRAIN GAGE MEASUREMENT,* and *MANY OTHER USEFUL FUNCTIONS!*

MODERN DESIGN

Everything about the new Westronics Universal Recorder is modern. Nothing old fashioned about this one! Note these features:

- COMPACT DESIGN (Only 8⅝" high)
- ZENER DIODE STANDARDIZATION
- PULL OUT CHASSIS
- PLUG-IN AMPLIFIERS
- BALL POINT PENS (That Really Work!)
- QUICK CHANGE CHART SPEED SELECTOR (No gears to change)

QUALITY

The new Westronics Universal Recorder features a servo system that uses ball bearings throughout. The pen carriage utilizes ball bearing motion on a precision ground track. No troublesome sheet metal parts sliding on rods on this one. Smooth ball bearing floating action is what makes dependable Ball Point inking practical.

VERSATILITY

The new Westronics Universal Recorder is second to none in versatility. Available in 5" and 11" strip chart sizes, single pen, 2 pen and multipoints.

ALL THESE FEATURES AND A COMPETITIVE PRICE TOO!

CALL ON ONE OF WESTRONICS 23 SALES-SERVICE REPRESENTATIVES TO HELP YOU SPECIFY A WESTRONICS UNIVERSAL RECORDER TODAY.

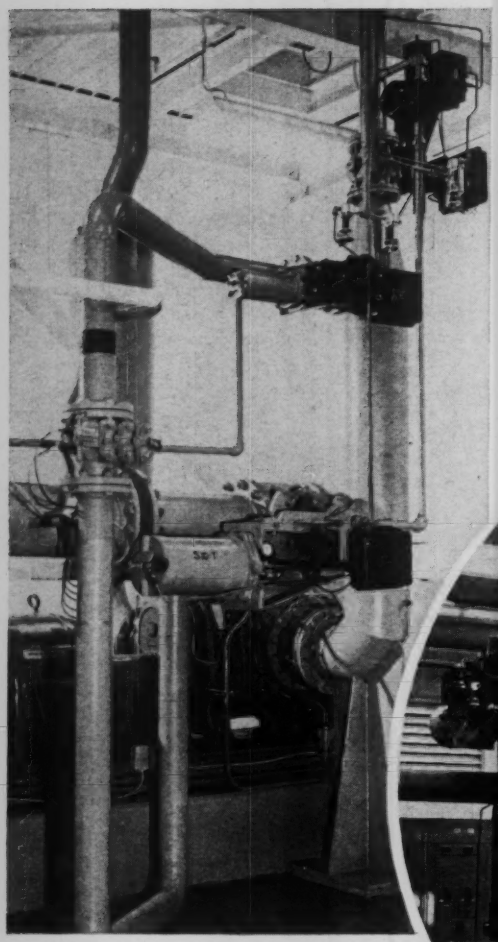
westronics, inc.

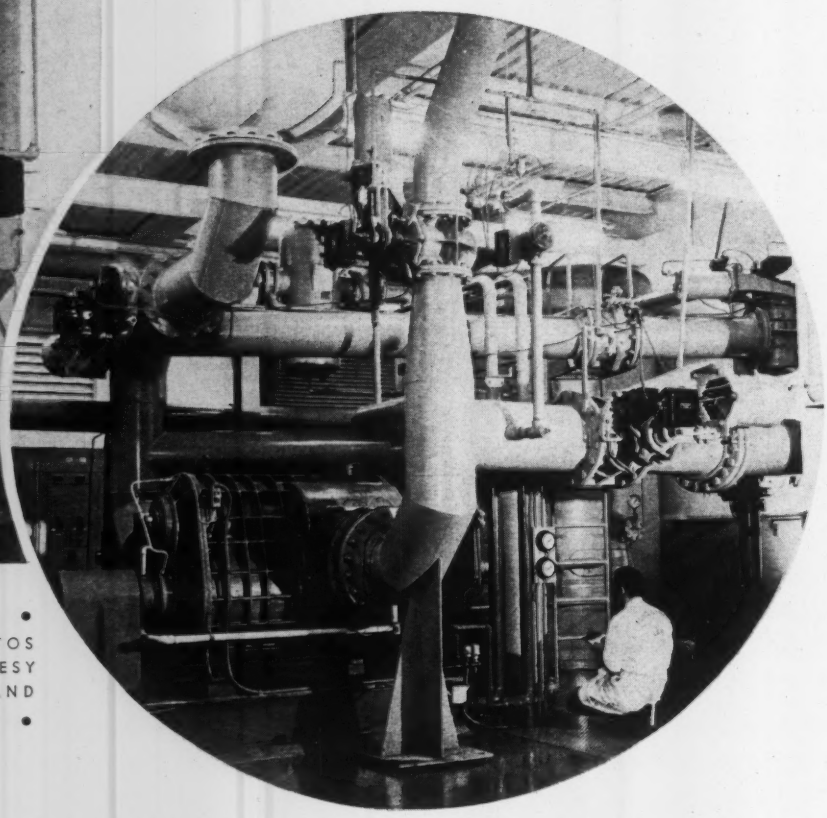
TWX FT 8248 U • 3605 McCART STREET • FORT WORTH, TEXAS

CIRCLE 41 ON READER-SERVICE CARD

WHEN AIR MUST MOVE AT *Missile Speed*

DeZURIK VALVES CONTROL the AIRFLOW





PHOTOS
COURTESY
INGERSOLL-RAND

FLIGHT CONDITIONS simulating full rocket and aircraft experience . . . . flows to 12,250 cfm of air at 5 psig, vacuums up to 24" Hg . . . . that's the job at this famed aero-test center in California. It's being done with DeZURIK CONTROL VALVES.

The control-system demanded simplicity, fast action, exit-pressure control to minimum tolerance, a myriad of flow combinations—plus absolute dependability, air-tight shut-off, certain safety, remote operation. DeZURIK CONTROL VALVES have provided all these features.

Eleven DeZurik "bleed and throttle" valves in sizes to 16" are involved on the primary and secondary compressor-exhausters. These instrumented valves have proved their total efficiency and trouble-free character in over 2 years of rigorous use in this complex space-age service.

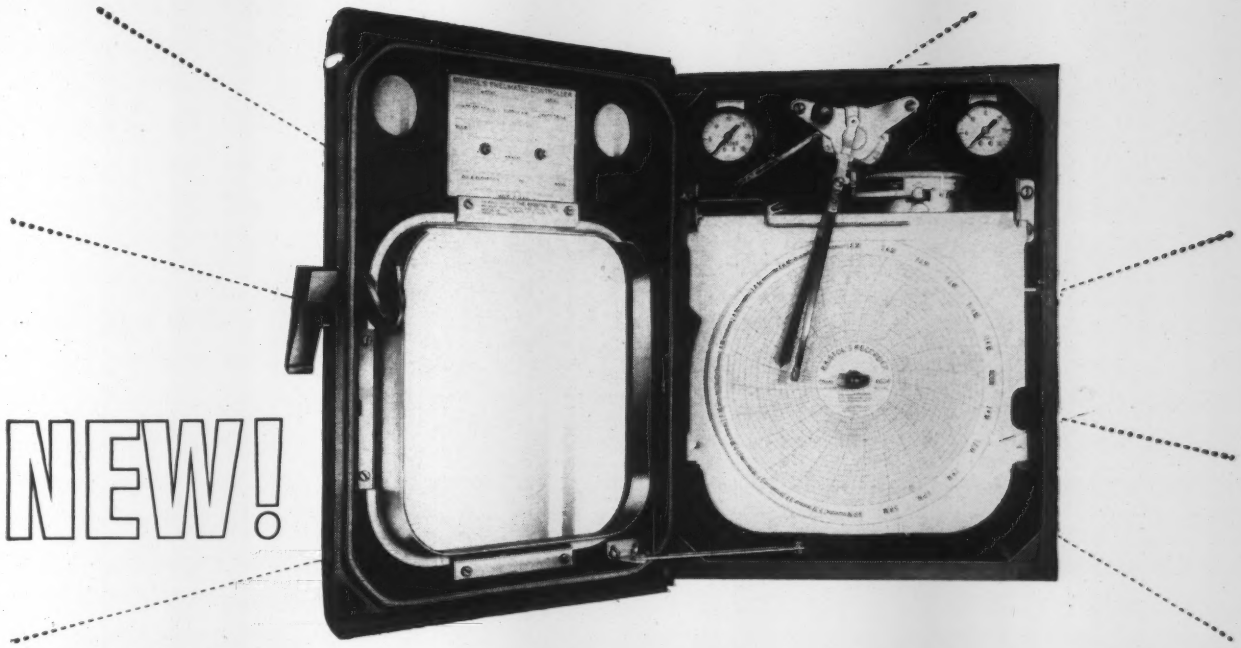
ASK FOR BULLETIN 150

DeZurik Corporation

SARTELL, MINNESOTA

In Canada: DeZURIK OF CANADA, LTD. Galt, Ontario

CIRCLE 42 ON READER-SERVICE CARD



NEW!

Bristol Series 532 A/D* pneumatic recording controller is outstandingly SIMPLE, RELIABLE, and STABLE

- **Simple modular design for ease of servicing**
- **High control stability for closer process control**
- **Designed for batch-type and continuous processes**
- **Proportional, proportional-plus-reset, and proportional-plus-derivative control models available**

Top control performance with maximum simplicity plus standard Bristol precision measuring elements—those are the key features of the Bristol Series 532 Recording Controller. The 532 uses the same renowned elements that have earned such a reputation for accuracy and dependability on other Bristol automatic controlling and recording instruments—perfected through wide experience and many years of development.

Self-contained modular design of the control unit speeds servicing. The whole modular unit, consisting of an aluminum casting with working parts made of stainless steel, Ni-Span C, and Neoprene diaphragms, can be removed by taking out only two screws and a link.

The die-cast aluminum instrument case (15¾ x 10¾ x 5¾ overall) presents a streamlined appearance and is completely dustproof and weatherproof.

Write for complete data on the new, versatile, economical 532 A/D. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn., a Subsidiary of American Chain & Cable Company, Inc. 0.46

ACCO

CONTROL UNIT CHARACTERISTICS:

PROPORTIONAL BAND: 0-400% continuously adjustable, direct- or reverse-acting.

RESET: 0.1 to 100 repeats per minute.

DERIVATIVE: 0 to 10 minutes derivative time.

AIR PILOT: Non-bleed type.

PILOT CAPACITY: Over 3.0 scfm.

FREQUENCY RESPONSE: Essentially flat to 300 cycles per minute.

TEMPERATURE STABILITY: Less than 0.1% change in the output pressure for 90°F temperature change.

CHART: 8″ diameter; wide variety available.

MATERIAL: Aluminum housing; 316 stainless steel internal parts; Ni-Span C feedback element.

RECORDING CONTROLLERS OFFERED FOR:

PRESSURE AND VACUUM: Ranges from full vacuum to 15,000 psi.

TEMPERATURE: Ranges from −100°F to +1000°F.

FLOW AND DIFFERENTIAL PRESSURE: With mercury-type manometer and dry-type differential unit.

LIQUID LEVEL: With bulb unit and mercury manometer and dry-type differential unit.

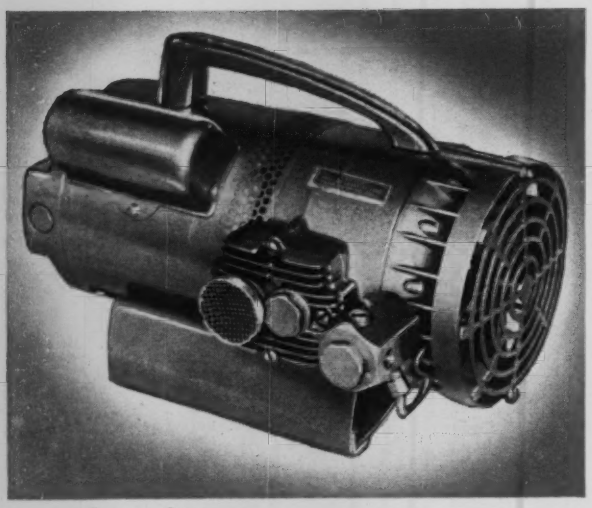
HUMIDITY: Zero to 100% relative humidity.

*Advanced Design

BRISTOL ...for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

CIRCLE 43 ON READER-SERVICE CARD



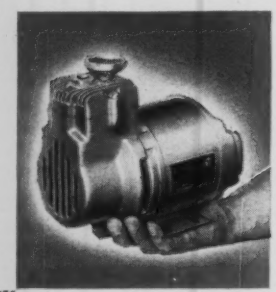
Oil-Free AIR FOR INSTRUMENTATION

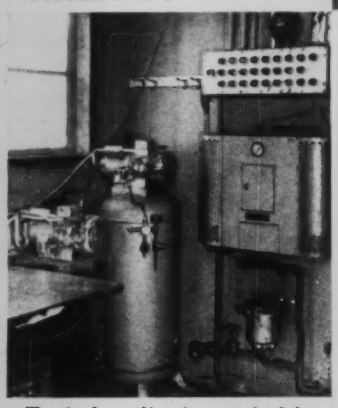
For instrument control with compressed air, patented B&G Oil-less Compressors offer outstanding, exclusive advantages.

They deliver air *completely oil-free!* Carbon-graphite piston rings and skirts need no lubrication; bearings are grease-packed and sealed for life. Numerous design and construction features assure dependable delivery of cleaner, cooler, drier air and smoother operation.

B&G Oil-less Compressors can be located at the site of the control, eliminating long pipe lines which may contaminate the air with dirt and condensation.

Available in 58 models... portable, tank mounted, motor and gas-engine driven, 1/12 to 3/4 H.P., up to 6.57 CFM, up to 190 psi. Vacuum: 27.5".





Typical application to air drier

MINIATURE!

1/12 H.P. Oil-less Motor Compressor and Vacuum Pump

Fits in the palm of your hand, yet delivers much more free air than any current design of the same horsepower. It is capable of continuous operation at pressures up to 65 psi.—has infinite applications for instrument control, process agitation and motive power.

Oil-less AIR COMPRESSORS

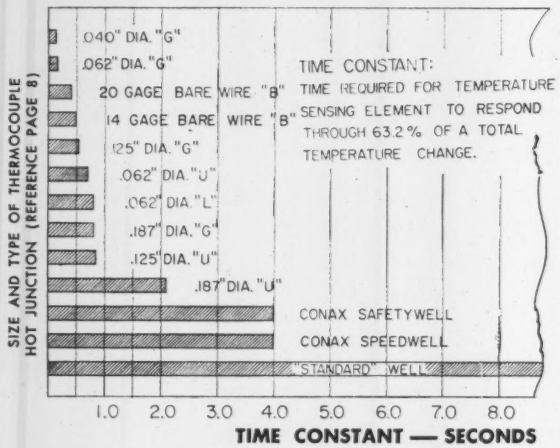
BELL & GOSSETT COMPANY

Dept. GV-84, Morton Grove, Illinois

CIRCLE 44 ON READER-SERVICE CARD

Mineral Insulated Thermocouples

Problem: To establish time constants for various sizes and types of Conax Con-O-Clad thermocouples and to show a graphic comparison.


SIZE AND TYPE OF THERMOCOUPLE HOT JUNCTION (REFERENCE PAGE 8)
.040" DIA. "G"
.062" DIA. "G"
20 GAGE BARE WIRE "B"
14 GAGE BARE WIRE "B"
.125" DIA. "G"
.062" DIA. "U"
.062" DIA. "L"
.187" DIA. "G"
.125" DIA. "U"
.187" DIA. "U"
CONAX SAFETYWELL
CONAX SPEEDWELL
"STANDARD" WELL
TIME CONSTANT:
TIME REQUIRED FOR TEMPERATURE SENSING ELEMENT TO RESPOND THROUGH 63.2% OF A TOTAL TEMPERATURE CHANGE.
1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0
TIME CONSTANT — SECONDS

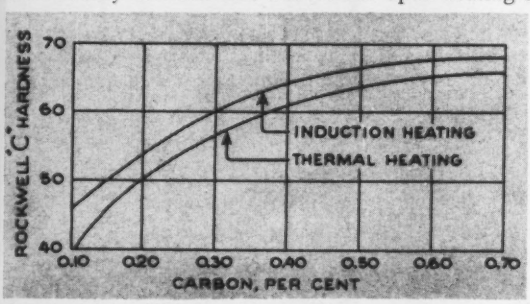
Procedure: Test thermocouples were immersed until saturated in an ice bath at zero degrees. They were physically removed from ice bath and immediately immersed in violently boiling water. Temperature rise was recorded by a high-speed Sanborn Potentiometer . . .

Conclusions: All the Conax Con-O Clad thermocouples tested responded practically instantaneously proving that the hard packed mineral insulation used in Conax Con-O-Clad is an excellent heat conductor . . . (*From new* 20-*page Catalog* 300, *Conax Corp.*, 2300 *Walden Ave.*, *Buffalo* 25, *N. Y.*)

FOR THIS LITERATURE CIRCLE 226 ON READER-SERVICE CARD

Induction Hardening

Ther-Monic process provides a method for differential heating between the surface of the steel part and its interior . . . Any material that will harden upon heating can



be hardened by TherMonic . . . There are three variable factors that govern thin case surface hardening; frequency, power per square inch and time . . . Industion hardening has many advantages over other existing methods; the metallurgical advantages are especially pronounced. Full hardness is uniformly maintained through most of the hardened zone, then falls off gradually between the case and the core . . . (*From new* 56-*page Catolog D*3-2, *Induction Heating Corp.*, 181 *Wythe Ave.*, *Brooklyn* 11, *N. Y.*)

FOR THIS LITERATURE CIRCLE 227 ON READER-SERVICE CARD

(*Continued on page* 1814)

Weller MAGNASTAT Soldering Irons are available from these Franchised Distributors

IN THE EAST

Baltimore, Maryland
Kann-Ellert Electronics, Inc.
2050 Rock Rose Avenue

Boston, Massachusetts
Cramer Electronics, 811 Boylston St.
De Mambro Radio Supply
1095 Commonwealth Ave.

Detroit, Michigan
Radio Specialties Co., 12775 Lyndon

Newark, New Jersey
Lafayette Radio Corp. of N. J.
24 Central Avenue

New York, New York
Harrison Radio Corporation
225 Greenwich Street
Terminal-Hudson Corporation
236 West 17th Street

Paterson, New Jersey
Garden State Tool Supply, 76 River St.

Philadelphia, Pennsylvania
Almo Radio Co., 913 Arch Street
Philadelphia Electronics, Inc.
1211 Vine Street

Pittsburgh, Pennsylvania
Radio Parts Co., 6401 Penn Ave.

IN THE MIDWEST

Chicago, Illinois
Allied Radio Corporation
100 North Western Avenue
Newark Electronics Corporation
223 West Madison Street

Cincinnati, Ohio
United Radio, Inc., 1314 Vine St.

Columbus, Ohio
Buckeye Electronics Distributors, Inc.
242 East Long Street

Dayton, Ohio
Srepco, Inc., 314 Leo Street

IN THE SOUTHWEST

Alamogordo, New Mexico
Radio Specialties Co., 209 Penn Ave.

Albuquerque, New Mexico
Radio Specialties Company, Inc.

Houston, Texas
Busacker Electronic Equipment Co.
1216 West Clay Street

IN THE WEST

Denver, Colorado
L. B. Walker Radio Co., 300 Bryant St.

Glendale, California
Claude Michael, Inc., 704 West Ivy St.

Grand Junction, Colorado
L. B. Walker Radio Company
537 North First Street

Inglewood, California
Newark Electronics Co., Inc.
4747 West Century Blvd.

Los Angeles, California
Garrett Supply Company
3844 South Santa Fe Avenue
Kierulff Electronics
820 West Olympic Blvd.
Radio Products Sales, Inc.
1501 South Hill St.

Phoenix, Arizona
Garrett Supply Company
2950 West Thomas Road

Pueblo, Colorado
L. B. Walker Radio Company
100 North Victoria

Salt Lake City, Utah
Strevell-Paterson Hardware Co.
1401 South Sixth—West

Seattle, Washington
Western Electronic Supply Co.
717 Dexter Avenue

Only Weller MAGNASTAT® Soldering Irons offer all these features!

HALF THE WEIGHT OF UNCONTROLLED IRONS

INTERCHANGEABLE TIPS PROVIDE 750°, 700° OR 600°F TEMPERATURES

2 OR 3-WIRE CORDS ARE AVAILABLE FOR ALL MODELS

HEAT CONTROL IS IN THE TIP

AUTOMATICALLY MAINTAINS CORRECT SOLDERING TEMPERATURE

GREATER HEAT EFFICIENCY WITH LOWER WATTAGE

COOLEST HANDLE

More than 40 tip types are available—made of copper for fast heat transfer and premium iron plated for long life. Advanced cord connection locks securely, yet permits easy replacement. Rubber shock absorber prevents iron from sliding off bench.

3 models cover all electrical and production line requirements

Model TC552 - 55 watts **$9.00** list
Model TC602 - 75 watts **$10.00** list
Model TC1202 - 120 watts **$11.50** list

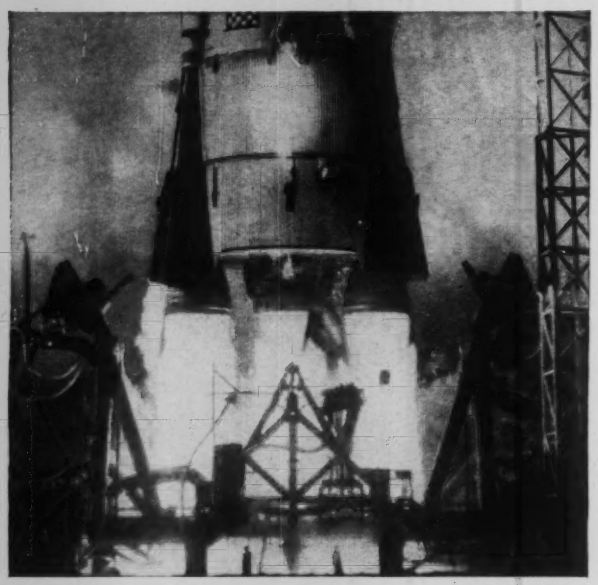
(prices shown are for irons with tip and 2-wire cord)

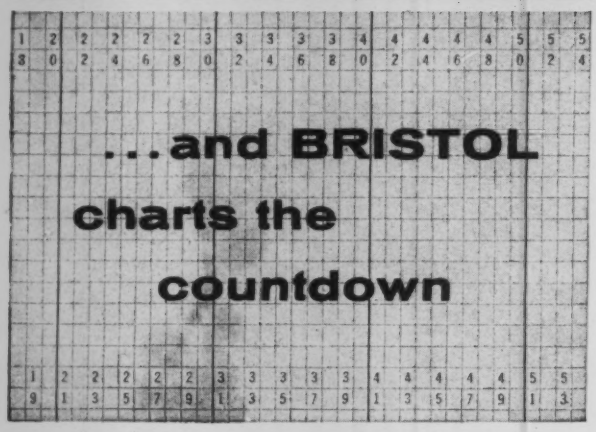
Send for NEW Magnastat Soldering Iron literature

WELLER ELECTRIC CORP. 601 STONE'S CROSSING RD EASTON, PA

CIRCLE 45 ON READER-SERVICE CARD

ATLAS AWAY!





Bristol charts (**sample** above) in specially built "time and event recorders" **at** Vandenberg Air Force Base tell engineers vital **facts** about the critical moments in the countdown and first few minutes of flight of each Atlas missile.

Printed for Convair (Astronautics) Division of General Dynamics Corporation, prime contractor for the Atlas missile, these charts are just one example of the hundreds of "specials" turned out every year at Bristol chart printing facilities—one of the largest, most complete plants of its kind in the country.

Strip charts up to 32" across, circular charts to 12" diameter can be handled. Standard chart papers of highest quality are available. Or, Bristol can print on a wide variety of special papers, such as papers for metallic marking, foil-type laminates, card stock, heat- and pressure-sensitive, carbon-coated, or photo-sensitive oscillographic papers.

Get in touch with Bristol if you're designing a special recording instrument. An entire special chart engineering service is at your disposal. Or, for more information about this service, write for Bulletin Y1906. The Bristol Company, 154 Bristol Road, Waterbury 20, Conn. 9.29

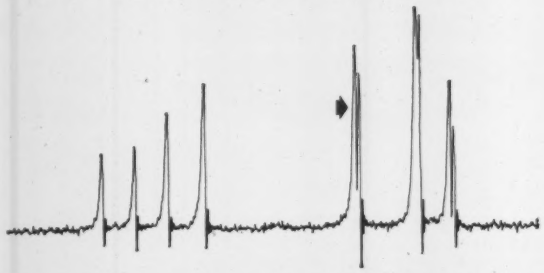
BRISTOL . . . for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

CIRCLE 46 ON READER-SERVICE CARD

Nuclear Magnetic Resonance

NMR Spectroscopy is based on the fact that many atomic nuclei possess a combination of charge and angular momenta, thereby resulting in a net magnetic moment. Importantly, the ratio of magnetic moment to angular momentum (the "magnetogyric ratio" is unique for every isotope possessing these properties . . .

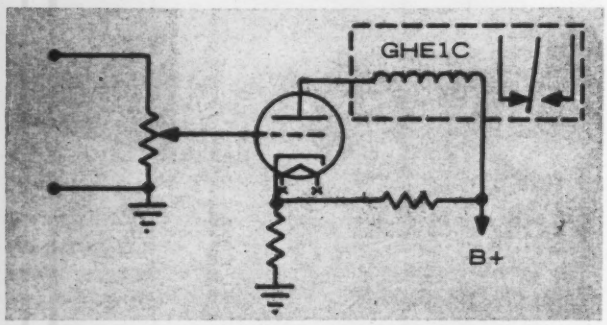


There are two basic division of NMR Spectroscopy—Wide-Line and High Resolution. Wide-line NMR concentrates on the board resonance characteristic of a particular nucleus in its many interactions with its surroundings . . . High Resolution NMR goes a step further: through highly precise instrumentation, it is able to detect the slight shifts and fine structure details that represent the differing intra-molecular environments for a given nucleus . . . The unmatched sensitivity and resolution of the HR-60 and DP-60 Spectrometers is clearly illustrated in the spectrum of Vinyl Chloride vapor under a pressure of several atmospheres. The two lines indicated are separated by approximately 0.8 cps at 60 mc . . . (*From new* 12-*page Brochure INS* 1419, *Varian Associates, Palo Alto, Calif.*)

FOR THIS LITERATURE CIRCLE 228 ON READER-SERVICE CARD

General Purpose Relays

GH Series General Purpose Relays feature low cost, ac or dc coils, open or dustite enclosures, 5 and 10 amp contact ratings, octal, plug, solder lug, and printed cir-

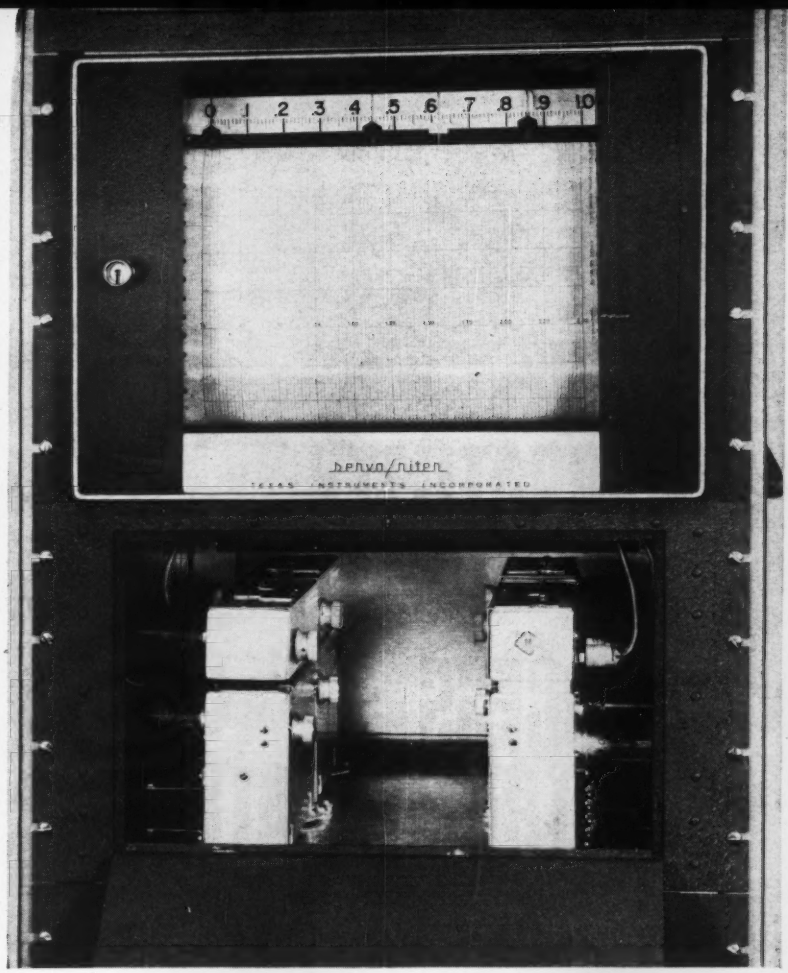


cuit tab connection, small size, SPDT, DPDT, and 3PDT contact arrangement, etc . . . Type GHE 5 amp plate circuit, dustile enclosure has contact arrangement: SPDT (1C), DPDT (2C), 3PDT (3C); contact ratings: 5 amps resistive, 2 amps inductive at 115v AC or 26.5 v DC, contact material: Fine silver, gold flashed nominal pull-in power: 1C contacts: 130 MW 2C contacts: 260 MW; 3C contacts: 350 MW . . . (*From new* 8-*page pocket-size brochure, Electronics Div. Elgin National Watch Co.,* 2435 *N. Naomi St., Burbank, Calif.*)

FOR THIS LITERATURE CIRCLE 229 ON READER-SERVICE CARD

(*Continued on page* 1818)

CIRCLE 47 ON READER-SERVICE CARD →



NEW from TI

4-CHANNEL servo/riter* RECORDER

RECORDS 4 CONTINUOUS CHANNELS ON A WIDE SINGLE CHART

You can now record four continuous channels of data on a wide single chart . . . four overlapping pens continuously recording on the full width of the 9¾" chart. For the first time in a potentiometric recorder four variables can be traced with high resolution on a single sheet of chart paper! The recorder is the proved *servo/riter* in the flush-mounting configuration for use in standard 19" relay racks.

Amplifiers are separate from the recorder and may be mounted as far as 15 feet from the recorder chassis. An optional factory-assembled package places the four amplifiers in a standard rack-mounting case for location adjacent to the recorder case.

In addition, five- and six-channel *servo/riter* recorders are available, utilizing overlapping pens on dual side-by-side 4½" charts. Two- and three-channel recorders are offered in both the narrow and wide configurations, with all pens writing on only *one* sheet of chart paper.

The same industry-proved performance characteristics and wide ranges of the single and dual-channel *servo/riter* recorders are designed into the new multi-channel instruments. These include:

- HIGH SENSITIVITY—
  1.0 mv to 100 mv full-scale
- HIGH INPUT IMPEDANCE—
  4 megohms off-balance
- FAST RESPONSE—
  .5 second full-scale rise time
- HIGH REJECTION RATIOS—

"Transverse"	1,000/1
"Longitudinal"	330/1
d-c Common Mode	30,000/1
d-c & a-c Guard	30,000,000/1

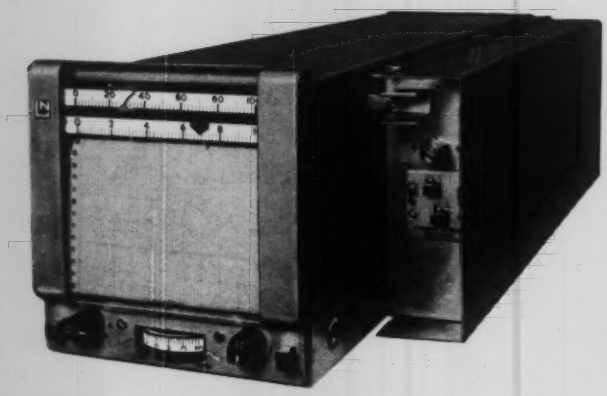
- HIGH RELIABILITY—Non-lash gearing and conservatively rated electronics.

Write for complete information.

APPARATUS DIVISION
PLANTS IN HOUSTON
AND DALLAS, TEXAS

TEXAS INSTRUMENTS
INCORPORATED
3609 BUFFALO SPEEDWAY
P. O. BOX 6027 HOUSTON 6, TEXAS

*Trademark of Texas Instruments



M LINE NEW VERSATILITY IN PROCESS INSTRUMENTATION

Evaluate it yourself, against your control requirements

M-Line Recording Control Station with M-Line TC/EMF Transmitter mounted above.

You'll quickly find that M-Line is the one miniature electronic control that's significantly different. *This* advanced instrumentation offers you a unique combination of advantages:

WIDEST SCOPE OF COMPATIBILITY IN OPERATION . . . can be used with almost any transmitters supplying a signal of 0.4 to 2 ma d-c, 0 to 4 ma d-c, 1 to 5 ma d-c, 4 to 20 ma d-c, 10 to 50 ma d-c, or 0 to 25 volts d-c output (complete list on request);

UNMATCHED INTERCHANGEABILITY OF COMPONENTS . . . display and/or control units of varying sophistication can be readily substituted (simply plugged into the basic stations) even after installation and start-up;

OUTSTANDING FLEXIBILITY IN OPERATION . . with set-point station, controller, auto-manual station and recorder (or indicator) independently removable, process will remain on control—automatic or manual—while these components are individually checked, serviced or replaced.

When your process demands competitively-priced instrumentation, with delivery in 6 weeks or less, you should investigate the sound investment that M-Line provides. Buy it and try it . . . you'll find M-Line the most advanced miniature instrumentation in electronic control. For more details, call your nearest L&N Field Office or write to 4955 Stenton Ave., Philadelphia 44.

LEEDS & NORTHRUP
Pioneers in Precision

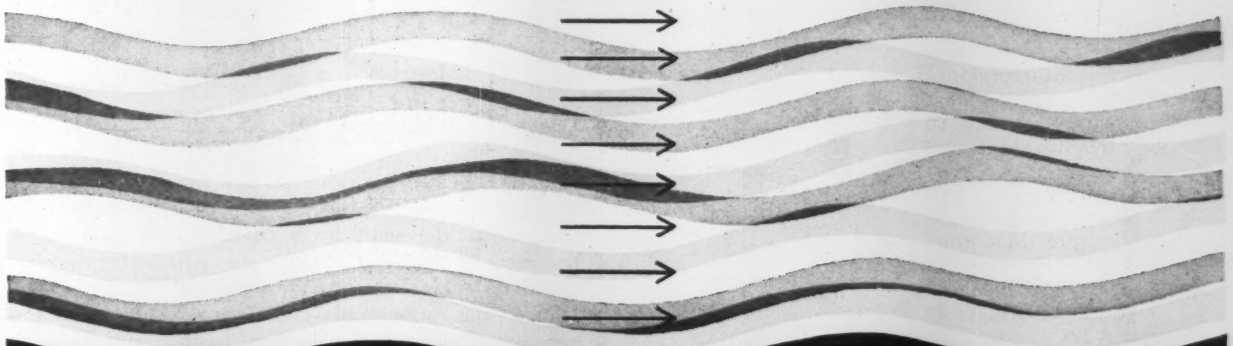
CIRCLE 48 ON READER-SERVICE CARD

Honeywell announces the NEW series 1400 low flow control valve

The addition of the new Series 1400 valve body to the Honeywell line of control valves now gives you a choice of actuator-body combinations to match your applications. Now you can choose the exact type and degree of control you need, without pushing a valve beyond its design limits . . . or without paying for more performance than you need.

The compact Series 1400 valve body is available in a full range of materials, ratings and sizes, with screwed or flanged ends. It can be used to regulate small flows in process, pilot plant, research and commercial control systems. Each body size (½", ¾" and 1") has a wide range of reduced ports with Cv's from .025 to 11.0. Two bonnet constructions facilitate mounting of five types of actuators —three pneumatic and two electric.

Each actuator-body combination fits a different range of operating conditions and performance characteristics, but with sufficient overlapping of these ranges to give you a wider selection on the basis of cost. For complete details, write for Bulletin B803-1. MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.



Model 1401 Low Flow Valve with heavy-duty pneumatic actuator for systems requiring high shut-off ratings and accurate valve positioning.

Model 1403 Low Flow Valve with compact, light weight pneumatic actuator for average industrial and commercial control systems.

Model 1404 Low Flow Valve with reduced port Cv's to .025 and top-mounted positioner integral with pneumatic actuator.

Model 1406 Low Flow Valve with *Modutrol* capacitor-type, electric motor actuator for two-position, floating or proportional control.

Model 1407 Low Flow Valve with heavy-duty *Actionator* electric motor actuator provides more power for higher valve shutoff ratings.

Honeywell

H First in Control

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

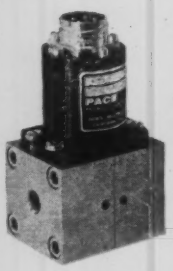
CIRCLE 49 ON READER-SERVICE CARD

PACE DC OUTPUT TRANSDUCERS

with integral Carrier-Demodulator combine the simplicity of DC operation with the performance advantages of magnetic reluctance transducers: Response, Shock and Overload Resistance, and Long Life.

ACCEPT CORROSIVE FLUIDS AND WITHSTAND EXTREME PRESSURE OVERLOADS

Measures low differential pressure at high line pressures. ±0.1 to 5,000 psid pressure ranges. Accepts corrosives, both sides, stainless exposure. Maximum line pressure of 5,000 psi. Operates on 115 VAC or 28 VDC.

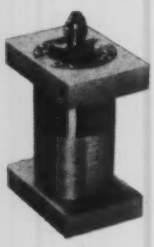


Model CP53D

Pressure Ranges of 0-200 to 0-10,000 psi, Gage or Absolute. Accepts corrosive liquids, gases and solid suspensions. 115 VAC or 28 VDC operation.

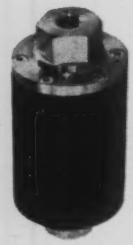
Model CP52

Qualified for Missile In-flight applications. Operates on 25-30 VDC. Available with ranges of 5 to 1,500 psi, differential, gage or absolute. Output, 0-5 VDC.



Model CP40

Pressure ranges of 0.1 to 2,000 psi, gage or differential; 5 to 2,000 psi, absolute. 115 VAC or 28 VDC operation. Accepts corrosive liquids and gases, both sides.



Model CP51

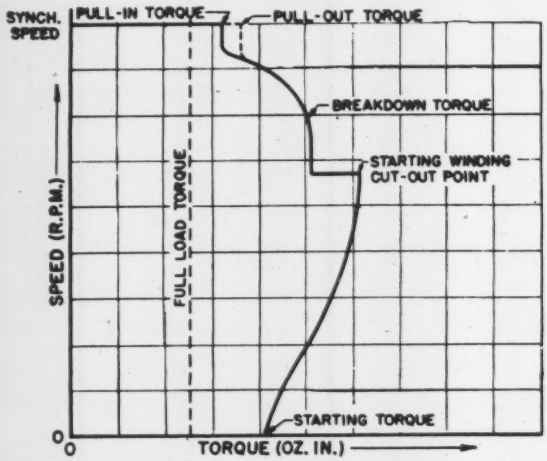
PACE *engineering company*

13035 Saticoy Street North Hollywood, California

CIRCLE 50 ON READER-SERVICE CARD

Synchronous Motors

There are two basic types of synchronous motor construction—reluctance and hysteresis . . . The differences are in the rotor construction. Reluctance synchronous rotors are of squirrel cage construction with salient pole

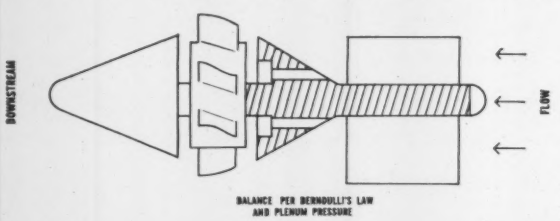


configuration, while hysteresis synchronous rotors consist of a heat treated, cast cobalt alloy cylinder, mounted securely to the shaft by a patented arrangement. No permanent magnets are used in any part of the magnetic circuit in either case . . . Within the limits of their full-load torque ratings, all synchronous motors operate at speeds completely in step with the frequency of the power source. For instance, a 4-pole motor will operate at exactly 1800 rpm on a 60 cycle power line . . . (*From new 20-page Bulletin 1036, Bodine Electric Co., 2500 W. Bradley Place, Chicago 18, Ill.*)

FOR THIS LITERATURE CIRCLE 230 ON READER-SERVICE CARD

Flow Transducer

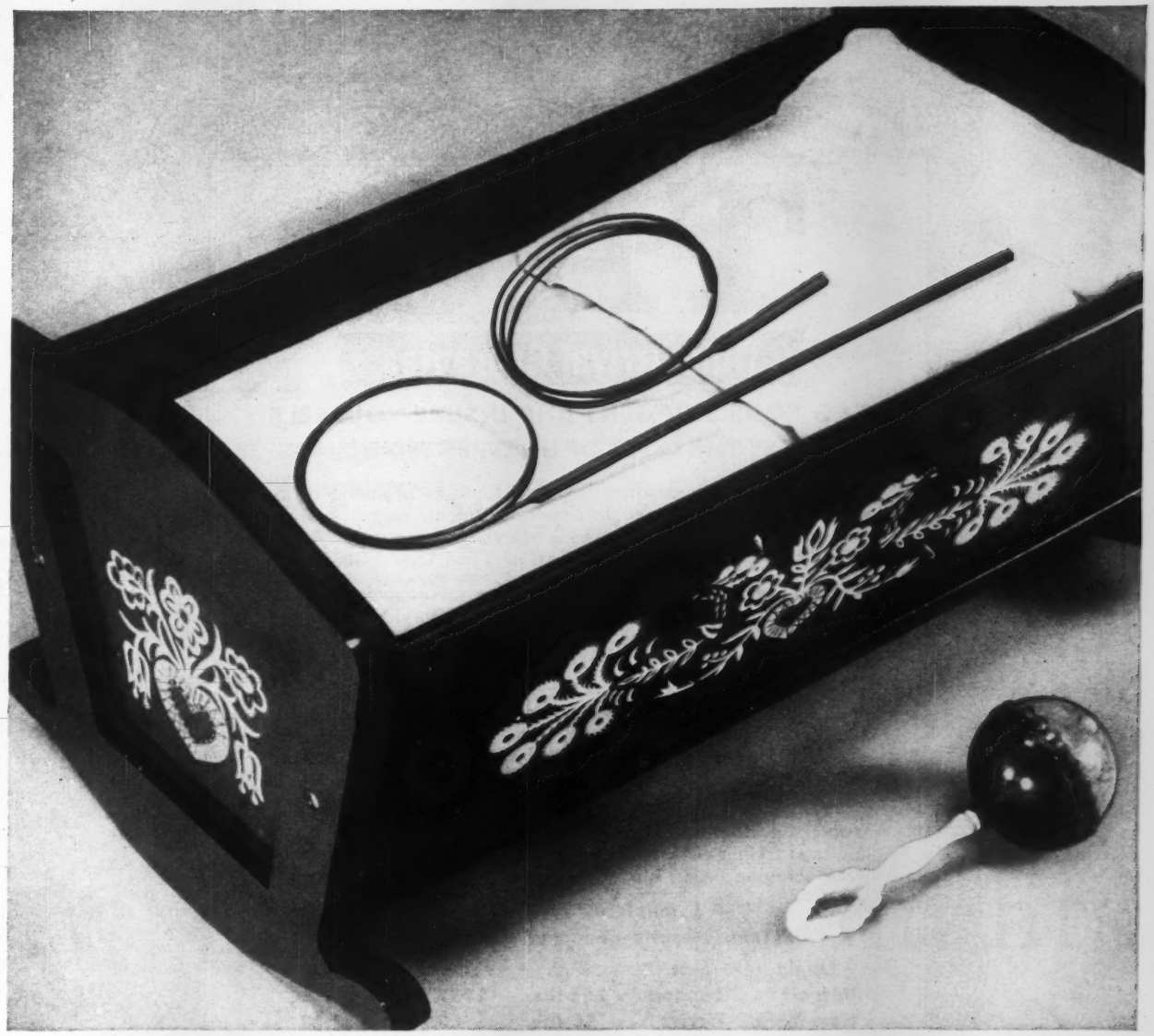
The HP Hydropoise Transducer is unique in that the rotor is hydrodynamically balanced; no thrust bearings are used. As fluid flows through the transducer, it causes the rotor to turn. The speed at which it rotates is directly proportional to the volumetric flow rate and the number of times it rotates is proportional to the total volume of fluid that has passed through the transducer. In close



proximity to the rotor blade tips, but mounted externally, is a variable reluctance pick-up. As each blade tip passes the pick-up, an electric impulse is produced. Thus, the rate of flow is proportional to the pulse frequency; the total volume of flow is proportional to the total number of impulses . . . (*From new 4-page brochure, Hydropoise, Inc., 230 S. Wells Fargo Dr., Scottsdale, Ariz.*)

FOR THIS LITERATURE CIRCLE 231 ON READER-SERVICE CARD

(*Continued on page* 1828)



NEWBORN!

New from Kensico: one-piece capillary tube and bulb assembly, in sizes for all types of instrumentation work. This new one-piece assembly for thermosensing elements is painstakingly produced by Kensico technicians using the utmost care to insure customer's exact specifications. Range offered includes bulb sizes up to ⅜" OD maximum, by any desired length, with capillary tubing down to a minimum of 0.010" ID. Single-piece design eliminates a joining operation in the assembly of instrumentation systems and gives the added efficiency of joint-free flow. Kensico normally ships these units in straight lengths although they are shown above coiled to indicate design. Call Kensico today. Discover how well deserved is our reputation as a Small Tube Specialist. Write KT-61, Kensico Tube, Mount Kisco, N.Y. for free copy of Air Flow Engineering Charts.

Kensico Tube
COMPANY DIVISION
Robinson Technical Products, Inc. • MOUNT KISCO, NEW YORK

Kensico Products are also available through Warehouse Distributors and Sales Representatives in Cambridge, Mass.; Middlebury, Conn.; Buffalo, N. Y.; Lindenhurst, N. Y.; Goshen, N. Y.; Roselle, N. J.; Philadelphia, Pa.; Flourtown, Pa.; Pittsburgh, Pa.; Cleveland, Ohio; Chicago, Ill.; St. Louis, Mo.; Milwaukee, Wisc.; Durham, N. C.; Dallas, Texas.

CIRCLE 51 ON READER-SERVICE CARD

TAG

Time Arrival Guarantee

TAG YOUR SHIPMENT AND INSURE YOURSELF AGAINST THE COST OF UNEXPECTED DELAYS!

KLM Royal Dutch Airlines is proud to make available to its customers a brand new shipper's service for air cargo: guaranteed arrival-time underwritten by a new and unique type of insurance. We are calling this service TAG . . . Time Arrival Guarantee.

KLM's outstanding record of performance makes such insurance feasible. Through more than forty years of service, KLM has held its position as the world's leading carrier of air cargo and has maintained its reputation for dependable, personalized service and for on-time delivery.

Naturally, delays in arrival are not anticipated in the normal pattern of KLM service. However, TAG gives you the following guarantee: should your shipment not arrive at airport of destination within 24 hours of its scheduled arrival time, the underwriter will reimburse you up to the amount of the transportation charges.

You can avail yourself of TAG's benefits at a premium of 1% of the total freight charges with a $1.00 minimum when you place your shipping order.

Example of TAG charges

Transatlantic General Commodities

Origin	*Dest.*	*Wgt.*	*Frt. Chgs.*	*TAG Chgs.*
Detroit	**London**	**255 lbs.**	**$137.70**	**$1.38**
New York	**Paris**	**56 lbs.**	**$ 60.48**	**$1.00**

If, for any reason, you have hesitated about using KLM's services, we hope that TAG will provide you with the added confidence you need.

GUARANTEE YOUR SHIPMENT WITH KLM'S TAG

Full details about TAG can be obtained from your local KLM office.

KLM ROYAL DUTCH AIRLINES
609 FIFTH AVENUE
NEW YORK.

CIRCLE 52 ON READER-SERVICE CARD

FOR THE ENGINEER

who can't sleep nights

If you're losing sleep over a sticky problem in automatic control, AE can help—because AE has a reputation for making things *work* automatically.

It's not surprising, considering our unique experience in the design of circuits and components for automatic telephone exchanges.

What's more, AE relays and stepping switches are unique in their own right—because they're built to have substantially zero variation in operating characteristics *for life.*

As an example: the AE Class B Relay, illustrated, provides hundreds of millions of operations with unfailing contact reliability, and seldom needs maintenance. For this reason, it is probably the most inexpensive relay you can use where infallibility is an essential.

AE relays and stepping switches are custom-made to *your* specifications—and are also available wired and assembled into complete control units. And we're always glad to suggest specialized circuits that may cut your end costs.

Want more information? Just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

Also yours for the asking: Circular 1702-E, *Relays for Industry,* and a new 32-page booklet on *Basic Circuits.*

AUTOMATIC ELECTRIC

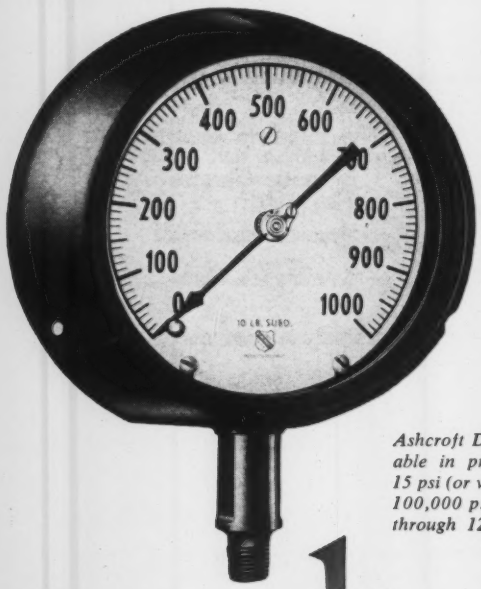
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

CIRCLE 53 ON READER-SERVICE CARD

accuracy

ASHCROFT DURAGAUGES measure pressure with precise accuracy no matter how severe the conditions of service



Ashcroft Duragauges are available in pressure ranges from 15 psi (or vacuum) minimum to 100,000 psi. Dial sizes: 4½" through 12".

sustained

The Bourdon tube in Ashcroft Duragauges is manufactured to precision standards of flexibility and mono-linked to the rotary movement. When pressure flexes the tube, the gauge pointer is always positively positioned, because it is mounted on the geared center shaft of the movement. Sustained high accuracy and long life are assured.

Choose your Ashcroft Duragauges made of components best suited to your needs. Eight Bourdon tube materials are available. Movement of stainless steel with nylon bearings and pinion gear for longest wear. Case materials: special aluminum alloy or tough phenol plastic.

The unique "Maxisafe®" Duragauge provides absolute protection to the viewer, plus easy and quick access to the mechanism. Your industrial supply distributor will help you select the best combination of components for your Ashcroft Gauge requirements. Phone him today or write for Catalog 300B.

MAXWELL MM&M MANNING & MOORE INC. TRADE MARK

ASHCROFT PRESSURE GAUGES

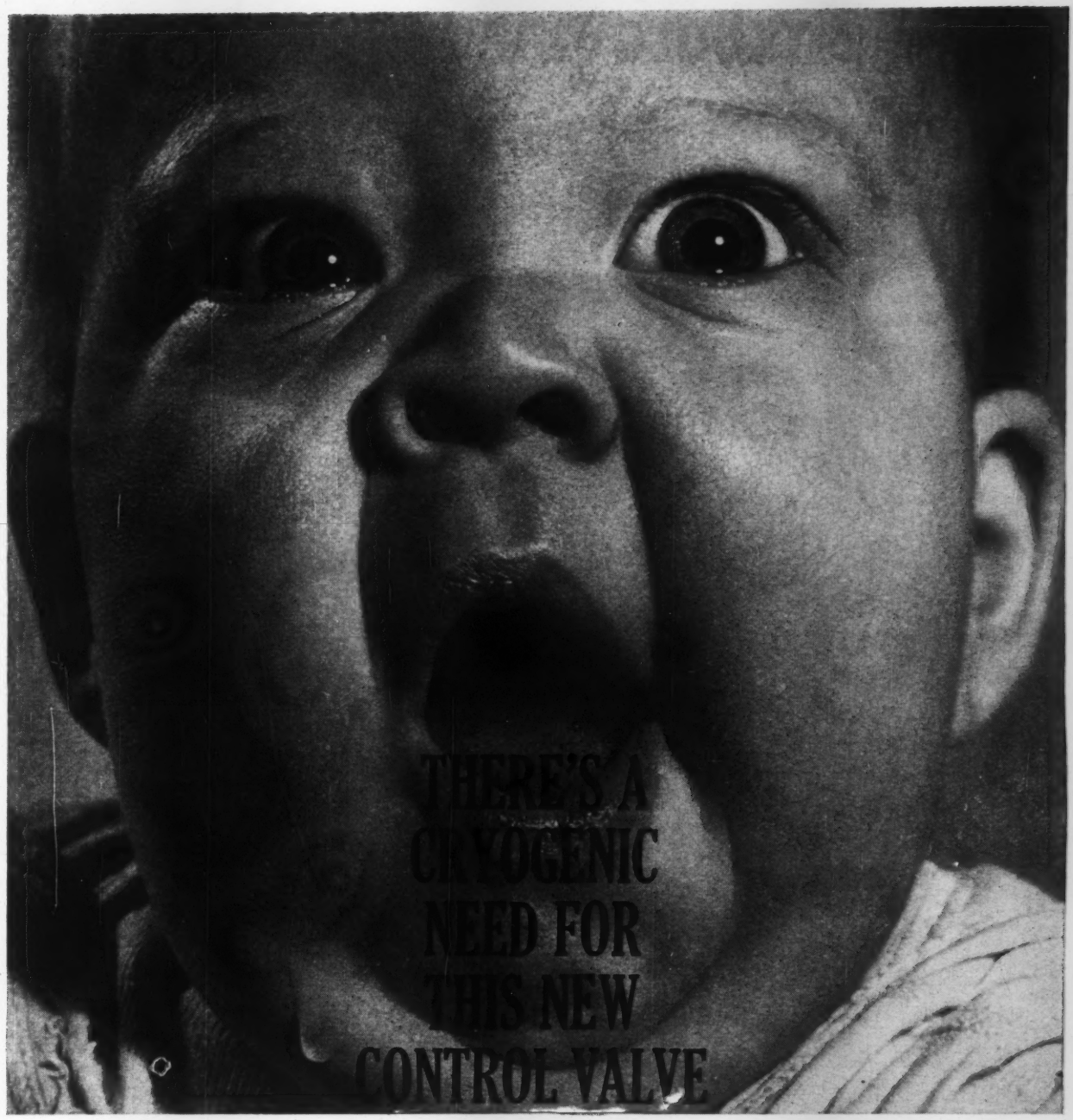
A product of

MANNING, MAXWELL & MOORE, INC.

Gauge and Instrument Division • Stratford, Connecticut

Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario
Latin America: Export Division, Chrysler Building, New York, N. Y.
Europe: Manning, Maxwell & Moore, S. A., Fribourg, Switzerland

CIRCLE 54 ON READER-SERVICE CARD



Welcome news—a throttling control valve that *doesn't* leak . . . even in cryogenic systems where extremely wide variations in temperature between start-up and defrost distort ordinary valves. This new Leslie Cage Trim design does away with seat ring threads and gasket crush problems—provides tight closing and service life unequalled by split-body or conventional globe type valves.

Solve another problem, too—speed in inspections. The valve can be completely disassembled in *minutes* from the top end without taking the valve body off the line. *Note:* Like all the other Control Valves in Leslie's complete line of single and double-seated types, it is easily adaptable at any time to changes in your system requirements.

For cryogenics, the new valve is available in ½″ to 4″ bronze or aluminum and ½″ to 2″ stainless steel; welding, flanged or screwed ends. For *standard* applications, the same basic design is offered at attractive prices in steel, stainless steel and alloy steel. Write today for further information, and engineering data.

LESLIE REGULATORS AND CONTROLLERS
A SINGLE STANDARD OF QUALITY SINCE 1900
Leslie Co., 704 Grant Avenue, Lyndhurst, New Jersey

CIRCLE 55 ON READER-SERVICE CARD

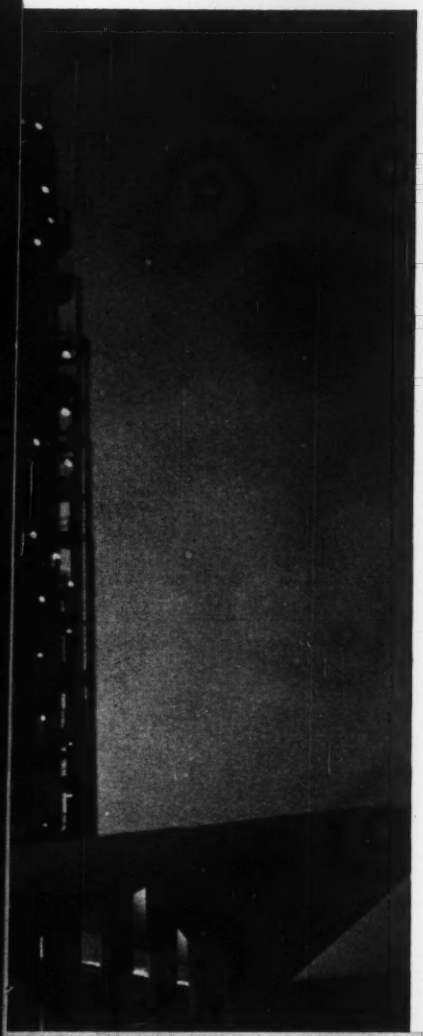
Foxboro pneumatic control huge Canadian

Photography by John K. Harris

THREE FOXBORO CONTROL PANELS for Imperial's Chemical Products Cracking Unit are housed in this unique hexagonally-shaped control room. Panels, which are arranged in a star-shaped pattern, contain 178 Consotrol recorders and controllers. Panels were built by The Foxboro Company, Limited, Montreal.

CIRCLE 56 ON READER-SERVICE CARD

installed at Refinery and Petrochemical Plant



Imperial Oil's giant Sarnia Plant counts on Foxboro Consotrol* instruments for accurate, dependable control

From its star-shaped control room to its towering columns, they've used the most advanced refining techniques at Imperial Oil's 94,000 barrel-per-day refinery at Sarnia, Ontario.

Little wonder that accurate, dependable, low-maintenance Foxboro Consotrol instruments were installed. For example, clay treating, cracking and fractionation, ethylene recovery, butadiene extraction, refrigeration, light ends, Hydrofining, Powerforming, debutanizing, detergent alkylation, and production of Naptha Specialties — all operate under Foxboro control.

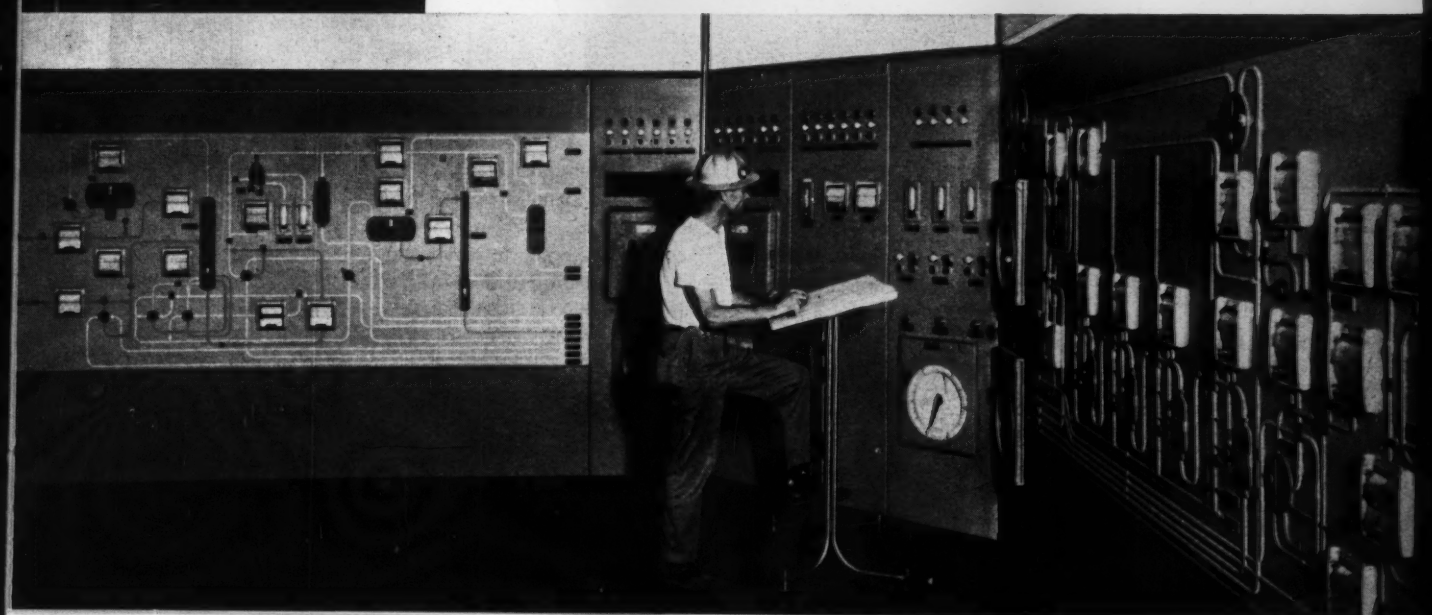
Actually, you'll find Foxboro small-case pneumatic consotrols serving leading refineries wherever reliable instrument performance is a must. If you're not familiar with the Consotrol story, ask your nearby Foxboro Field Engineer for full details. Or write for Bulletin 13-18. The Foxboro Company, 4610 Neponset Avenue, Foxboro, Massachusetts.

Reg. U. S. Pat. Off.

FOXBORO

REG. U.S. PAT. OFF.

THESE FOXBORO CONSOTROL PANELS are installed in the Powerformer Unit Control Room.



***REEL-IABILITY** — that quality in tape which reduces computer down-time and operating costs . . . which guarantees (repeat, guarantees) 556 bits per inch with no dropouts in your severest applications. This kind of reliability (no matter how you spell it) you find only in new Computape, a truly premium quality heavy duty computer and instrumentation tape.

COMPUTAPE: the facts

Computape utilizes a new, heavy-duty coating applied to proven Mylar* backing. This revolutionary formulation combines extra heavy duty usage with minimum of wear products. Highly conductive coating prevents accumulation of static charges. Magnetic properties are specifically designed for high density, high resolution data recording, with binders carefully selected to assure non-aging.

Manufactured start-to-finish in completely controlled dust-free facilities (our plant is, as far as we know, the world's newest) Computape is the product of the only company devoted exclusively to the manufacture of quality tapes for data processing and instrumentation.

Investigate Computape today. Better still, immediately.

COMPUTRON INC.

122 Calvary Street, Waltham, Massachusetts

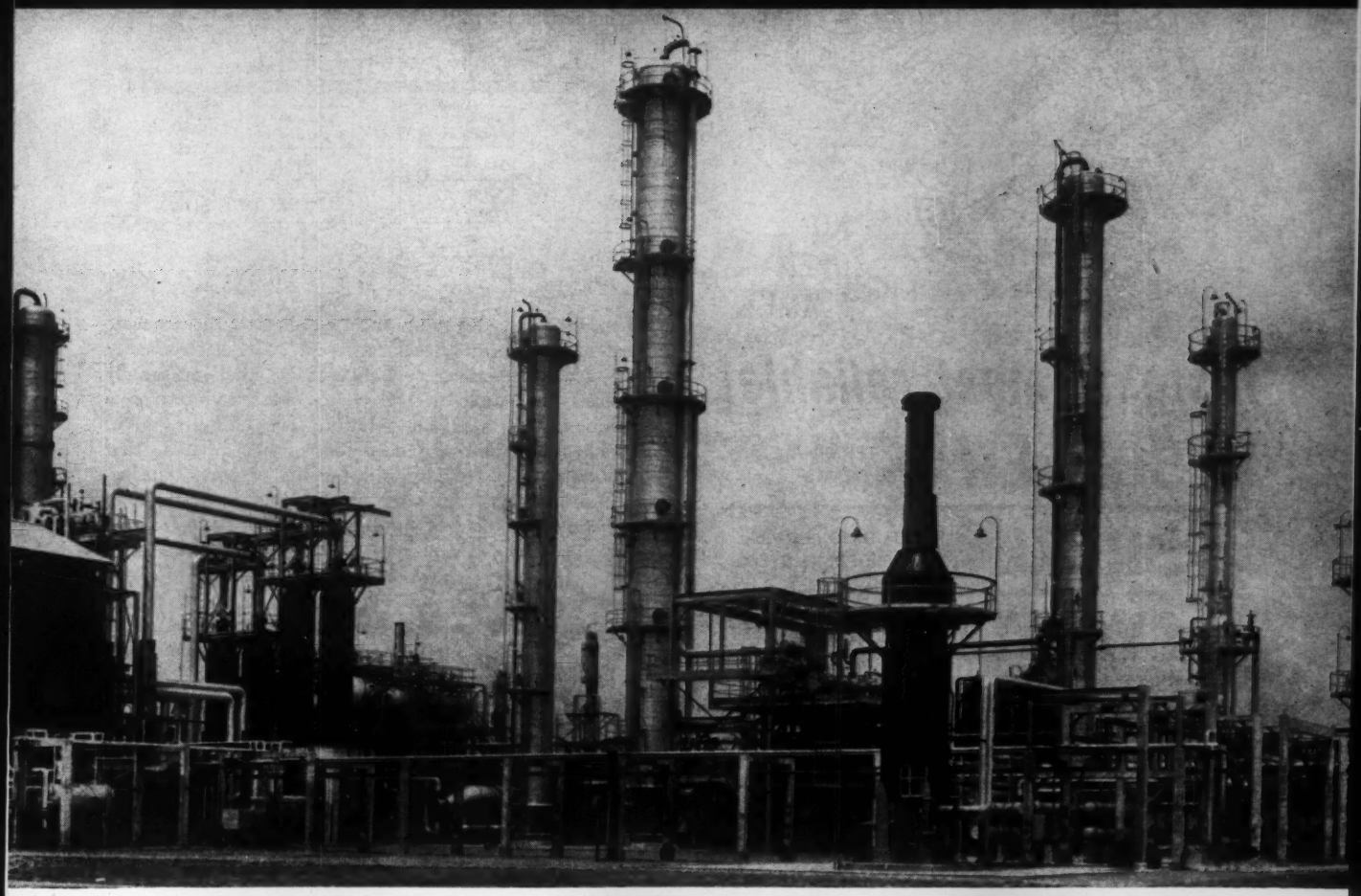
*T. M. DUPONT

CIRCLE 57 ON READER-SERVICE CARD

CIRCLE 58 ON READER-SERVICE CARD —→

PANALARM® RELIABILITY

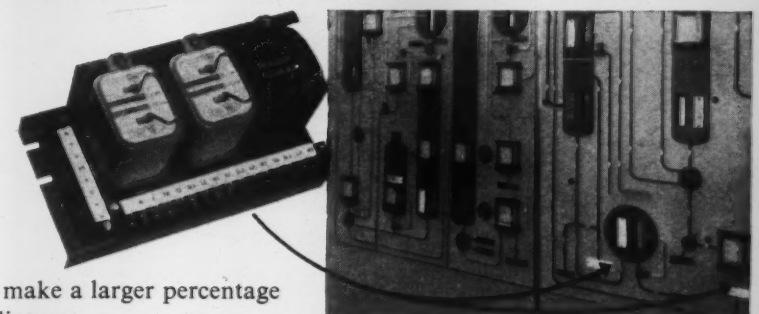
CHOSEN BY UOP® AND SHELL



View of 16,000 BPSD PLATFORMING® unit at the Houston, Texas, Refinery of SHELL OIL COMPANY, licensed by UNIVERSAL OIL PRODUCTS COMPANY and designed in conjunction with Shell.

DEPENDABLE MONITORING SINCE INSTALLATION IN 1956

The Panalarm remote system is particularly suited for central graphic control panels used in most refining processes. Back-lighted nameplates are conveniently located in the process flow and actuated remotely by hermetically sealed alarm relays mounted in strip chassis or adapter cabinets. Meets Class I, Group D, Division 2 requirements.



The Platforming® process enables a refiner to make a larger percentage of top quality gasoline and petrochemical intermediates.

Every major oil and petro/chem firm uses reliable Panalarm Annunciators.

Panalarm maintains a large staff of annunciator engineering specialists to assist with special annunciator design and application problems. For your specific annunciator requirements, contact Panalarm; sales and engineering offices are in all principal cities. Your inquiry will receive prompt attention.

Panalarm Annunciators warn Platformer™ operators when undesirable conditions develop at critical points by illuminating appropriate translucent plates on this graphic control panel, only a portion of which is shown. When desired, a simultaneous audible signal also attracts attention.

ISI PANELLIT

ANNUNCIATORS · CONTROL PANELS · DATA SYSTEMS

A division of ISI Incorporated

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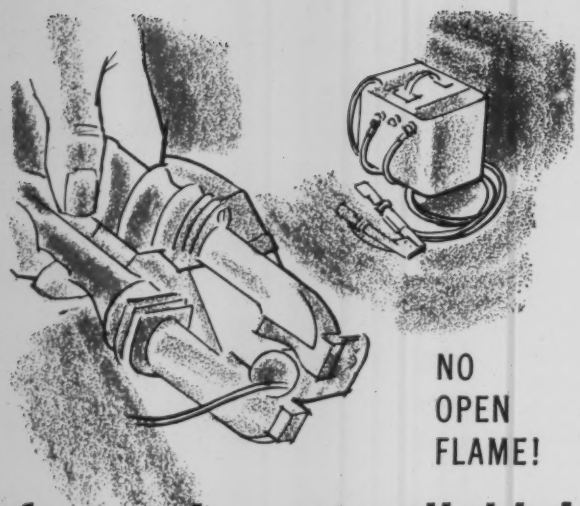


NO OPEN FLAME!

fastest! most reliable!

SOLDER LUGS, TERMINALS, WIRES, SEAMS

BRAZE LEADS, TUBING, BRASS, BRONZE, COPPER, STEEL

SWEAT FITTINGS, TUBING

IDEAL® THERMO-GRIP®
RESISTANCE SOLDERING SETS

Instant resistance heat concentrated at point of contact joins parts in seconds. *Work piece heats first*, melts solder, positively prevents cold-flow joints. No pre-heating — no burning of nearby parts. . . . Heat is controlled by thumb-switch. Low voltage and completely insulated parts eliminate accidental shock . . . Compact, rugged units draw current only when in use — cut power costs. Universal application: production, maintenance or repair, in electrical, metalworking, plumbing, heating, air-conditioning and general industry . . . Proved in hundreds of plants to increase output, cut costs, insure better soldering.

5 MODELS . . . 450 to 7500 watts. Plier, fork, pencil attachments with replaceable electrodes and other accessories. Sizes, models and powers for all needs.

Thermo-Grip soldering can save your company money. Mail coupon today for catalog data.

IDEAL INDUSTRIES, Inc. (IDEAL)
1420-J Park Avenue, Sycamore, Illinois
Please send catalog on Ideal Thermo-Grip sets.

NAME_____

COMPANY_____

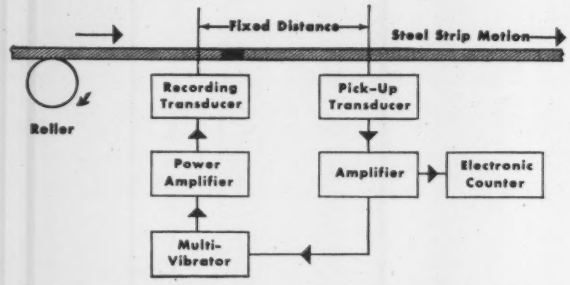
ADDRESS_____

CITY_____ ZONE____ STATE_____

CIRCLE 59 ON READER-SERVICE CARD

How to Use Sensors

Sensing devices (optical, infra-red, magnetic, electromagnetic and nuclear) are now being used to inspect; control quality; measure temperature, thickness or moisture; validate and detect in a wide variety of products and industries . . .

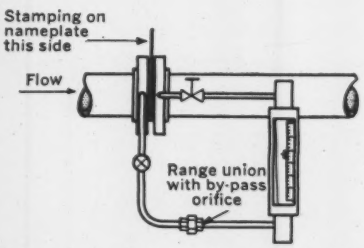


A particularly difficult control problem is the accurate lineal measurement of steel strip . . . An electronically controlled magnetic recording sensor, that accurately measures the length of steel plate being produced on a continuous line, was our solution. The unit also gives a synchronized pulse for each foot of steel plate so that the pulse may be fed into data logging or other data acquisition systems to give the producer an accurate, foot-by-foot measurement of his production . . . Electromagnetic principle is employed to obtain accurate strip lengths. Distance between recordings and pick-up transducers is fixed. Tinplate line operates at speeds up to 2400 fpm . . . (*From new 4-page Progress Report, Vol. 1/No. 2, Designers for Industry, Inc., 4241 Fulton Parkway, Cleveland 9, Ohio.*)

FOR THIS LITERATURE CIRCLE 232 ON READER-SERVICE CARD

By-Pass Rotameters

By-Pass Rotameters measure fluid flow rates in pipes of two-inch or larger sizes using relatively low-cost orifice plates, flow nozzles, venturi tubes or other "differential producers," while retaining the basic advantages of the rotameter.



The differential producer is located in the main pipe line in the conventional manner. A by-pass line including a rotameter and an additional orifice plate is attached at the normal pressure connections.

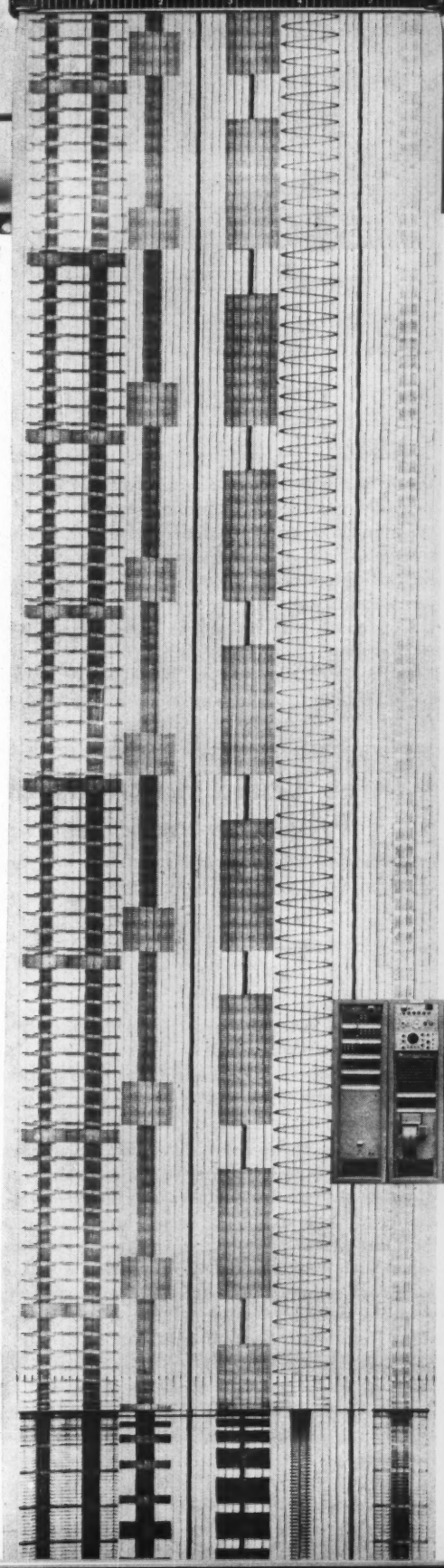
Flow rates in both the main line and the rotameter by-pass line depend upon the pressure drop across the orifice or other differential producer. Because the same pressure drop exists across each line, the flow rate through the by-pass line is always in direct proportion to that through the main line . . . (*From new 8-page Bulletin 116, Brooks Instrument Co., Inc., Hatfield, Pa.*)

FOR THIS LITERATURE CIRCLE 233 ON READER-SERVICE CARD

(*Continued on page* 1830)

CIRCLE 60 ON READER-SERVICE CARD →

Visicorder and record shown approx. ½ actual size.



Record speed changed during recording.

"MASTER CLOCK"

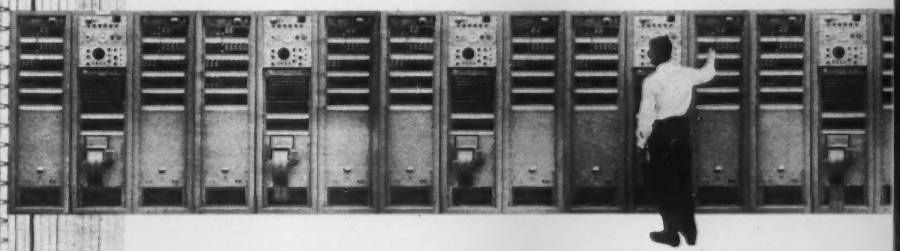
for the missile range uses 15 Honeywell Visicorder oscillographs

The Timing Operations Center designed and built by Epsco-West for the Navy's Pacific Missile Range is now in use at Point Mugu, California. It makes use of 15 Honeywell Visicorders to read out (as shown on the unretouched record at left) the modulated timing codes distributed as balanced outputs to the Center's "customers."

The solid-state Epsco-West TOC generates up to 11 separate timing signals, one or all of which may be delivered to any of 36 users.

The 906B Visicorder also performs a supplementary function as a monitor on the timing and test-patch panel, and as permanent "record-keeper" for the built-in indicators and test oscilloscopes. Visicorders were selected for their jobs with the TOC because of their versatility, reliability, low cost, and compact size ((10" x 10" x 15½"; weight, 37 lbs.).

Pioneer and acknowledged standard in the field of high frequency direct-recording oscillography, the Visicorder is available in several models, from 6 to 36 channels, DC to 5000 cps response, up to 50,000"/sec writing speed. Honeywell engineering is at your service through 120 field offices for help in applying one Visicorder or a full system to your data acquisition program; or a quantity of Visicorders for OEM application in your products.



Call your local Honeywell office now or write today for Catalogs HC906B, 1012, 1108, and 1406 to Minneapolis-Honeywell, Heiland Division, 5200 East Evans Avenue, Denver 22, Colorado. Our telephone is SKyline 6-3681, Area Code 303.

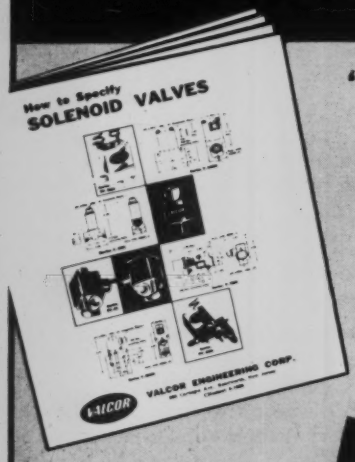
Honeywell

First in Control

SINCE 1885

CIRCLE 60 ON READER-SERVICE CARD

FREE SOLENOID VALVE DATA!...from VALCOR



"HOW TO SPECIFY SOLENOID VALVES", an 8-page brochure complete with drawings, diagrams, charts and curves.

"SOLENOID VALVE SELECTIONS FOR CORROSIVE APPLICATIONS", a 16-page manual listing over 500 corrosive media.

Both are free. Both should be at your fingertips.

Write today for your copies!

VALCOR SOLENOID VALVES

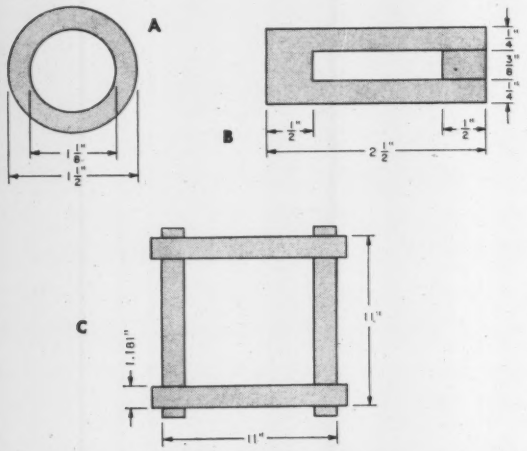
VALCOR ENGINEERING CORP.

5366 Carnegie Avenue, Kenilworth, N. J. • CH 5-1665

CIRCLE 61 ON READER-SERVICE CARD

High Permeability Alloys

The Carpenter Steel Company's high permeability alloys HyMu "80" and High Permeability "49" Transformer Grade are widely used in the form of die-cut laminations to form cores of transformers and other devices

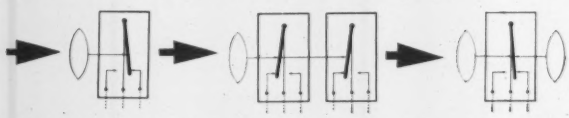


for use over a wide range of audio frequencies . . . Bulletin provides considerably more information in the form of a.c. inductance and impedance permeability values for both types of alloys in each thickness. In addition, d.c. magnetization permeability curves, plus a range of values of permeabilities, are given for both "49" and "80" alloys. Condensed information is provided on two additional Carpenter high-permeability alloys: Hy-Ra "80" and Hy-Ra "49" . . . (*From new* 40-*page Bulletin B*3, *Magnetic Metals Co., Hays Ave. at* 21*st St., Camden* 1, *N. J.*)

FOR THIS LITERATURE CIRCLE 234 ON READER-SERVICE CARD

Three Basic Functions of Pressure Switches

Single setting switches will open or close one electrical circuit at a given pressure setting.



Dual control switches have two switching elements actuated by one sensing element. This allows the pressure switch to control two independent electrical circuits. Easy switching element can be set to actuate at a different pressure setting.

Differential switches sense a pressure drop between two closed systems, such as occurs in the inlet and outlet side of a filter. Differential switches are independent of surrounding air or ambient pressure. The reference pressure is the more stable pressure, and the variable pressure is the one which fluctuates the most. In other words, a differential switch senses a pressure difference between a variable and a reference pressure . . . (*From new* 20-*page Design Handbook Section of Catalog* 61-62, *Bulletin* 610430, *Barksdale Valves, Pressure Switch Div.,* 5125 *Alcao Ave., Los Angeles* 58, *Calif.*)

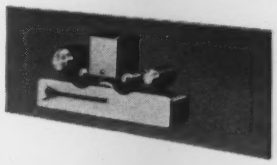
FOR THIS LITERATURE CIRCLE 235 ON READER-SERVICE CARD

(*Continued on page* 1834)

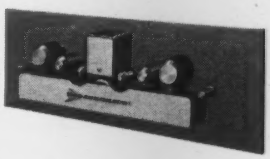
For a Complete Line of
Perforated Tape Equipment

DIGITRONICS

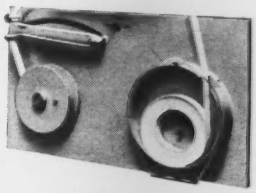
High Speed, All Solid State HANDLERS and PHOTO-ELECTRIC READERS



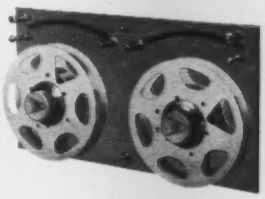
MODEL 3500 Uni-Directional Reader. Speeds to 2000 cps. Stops before the following character at 1000 cps.



MODEL B3500 Bi-Directional Reader. Speeds to 1000 cps. Stops before the following character at 1000 cps.

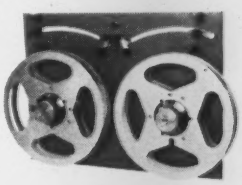


MODEL 4544 Uni-Directional Tape Handler. For use with model 3500 readers. Handles 500 feet of 5 to 8 level tapes interchangeably at speeds to 500 cps.

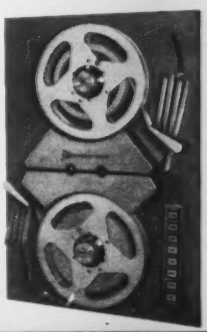


MODEL 4577 Bi-Directional Tape Handler. Handles 500 feet of 5 to 8 level tapes interchangeably at speeds to 500 cps. Rapid rewind at 1000 cps.

MODEL 4566 Bi-Directional Tape Handler. For use with model 3500 or B3500 readers. Handles 500 feet of 5 to 8 level tape, in either direction, at speeds to 400 cps. Rapid rewind at 1000 cps.



MODEL 4599 Bi-Directional Tape Handler. Handles 1000 feet of 5 to 8 level tapes interchangeably at speeds to 250 cps.



MODEL 4500 Integrated High Speed Bi-Directional Reader. Full servo reel control. Speeds to 600 cps. while handling 1000 feet of 5 to 8 level tape. Integrated electronics chassis contains vacuum tube reel servos, solid state controls and channel amplifiers.

No matter what your requirements . . . whether for use with digital computers, machine tool controls, ground support or other instrumentation . . . 8 basic Dykor® models each of modular design allow Digitronics to tailor its equipment to meet your specific requirements. All solid state construction for years of low maintenance operation. Speeds from 50 to 2,000 characters per second, 5 to 8 level interchangability, dual speed motors and many other Digitronics options.

See your local Digitronics representative or write for full technical information to:

DIGITRONICS CORPORATION
Albertson Ave., Albertson, L. I., New York • Area Code 516 HT 4-1000

CIRCLE 62 ON READER-SERVICE CARD

Solve Multi-Point Temperature Control Problems...

at ⅔ cost of competitive systems

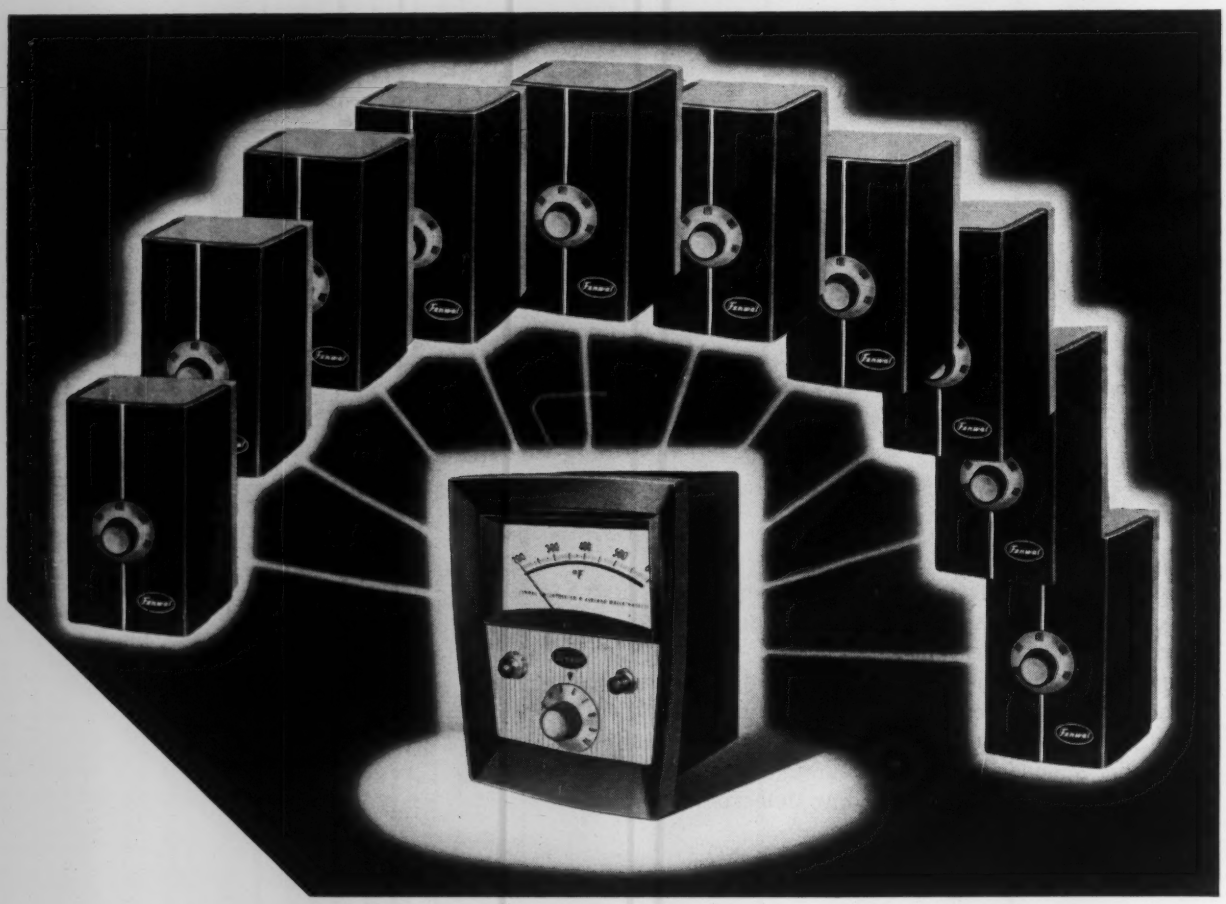
You get them all — wide ranging versatility . . . maximum sensitivity . . . easy installation and servicing! These features *combine* in a Fenwal 536-580 multi-point monitoring system to give you precise, transistorized temperature control and indication. And *you choose the features you need to suit your own requirements!*

Examine these cost saving advantages: Indication and control circuits are separate . . . the 536-580 system eliminates the need for separate indication and control at each point. You can build a control system concurrent with your needs — start with 2 points and build up to 10 points without paying a premium at the outset. The complete control system is built from *standard* catalog parts, thereby eliminating the need to buy costly "specials" for servicing at a later date.

Individual points can have either proportioning or ON/OFF control modes. The system permits "flick of switch" indication of from 2 to 10 temperatures. Individual set points can be adjusted from a central control panel or through a separate potentiometer remotely located. You select your own number of points and you *pay only for the options you use.*

Choose from five standard temperature ranges — from −50 to 600°F . . . expanded scales permit fine temperature adjustments and improved readability, and *the entire system gives you sensitivity to within 0.1°F.*

Both instruments are smartly styled to perfectly complement modern industrial machines and interiors. A Fenwal engineer will be glad to supply information on this system, or any other temperature control in Fenwal's broad line. Write Fenwal Incorporated, 3610 Pleasant Street, Ashland, Mass.



Another example of how **Fenwal** CONTROLS TEMPERATURE . . . PRECISELY

CIRCLE 63 ON READER-SERVICE CARD

CIRCLE 64 ON READER-SERVICE CARD →

Communications versatility at your fingertips

With Teletype Model 28 printers your messages and data can be sent quickly and economically to any destination, near or far. But this is only part of the story—these printers offer an array of optional features that can multiply the usefulness and versatility of your communications system, save you important time and effort. Here are examples:

- Pin-feed platen for controlling multi-copy business forms.
- Choice of platen widths to accommodate almost any size form or message paper.
- Vertical as well as horizontal tabulators.
- Automatic form feed-out—spaces out completed form with one key stroke, brings next form to starting position.
- Variety of type styles and sizes.
- Parallel-wire arrangement for business machine print-out.
- Built-in sequence selector for controlling remote equipment.
- Adaptable for DATA-PHONE and telegraphic communications services.

Teletype equipment is manufactured for the Bell System and others who require the utmost reliability from their data communications systems. For further information write to Teletype Corporation, Dept 22K, 5555 Touhy Avenue, Skokie, Illinois.

TELETYPE®
CORPORATION • SUBSIDIARY OF *Western Electric Company* INC.

EPLAB

PYRHELIOMETER
For the Measurement of SOLAR RADIATION

Eppley Pyrheliometers are used for solar radiation measurements at ninety-eight weather stations in the continental United States, Canada, Alaska, Greenland, Iceland, Caribbean Sea, and the Pacific Ocean. Sixty-two of these stations are under the direction of the United States Weather Bureau.

The Eppley Pyrheliometer was adopted as standard equipment by the Weather Bureau after considerable experimentation. It was found to be the best instrument so far tested by the Bureau.

Used in conjunction with a suitable recorder, the Eppley Pyrheliometer will provide an accurate and reliable record of total solar and sky radiation on a horizontal surface.

Bulletin No. 2 on Request

THE EPPLEY LABORATORY, INC.

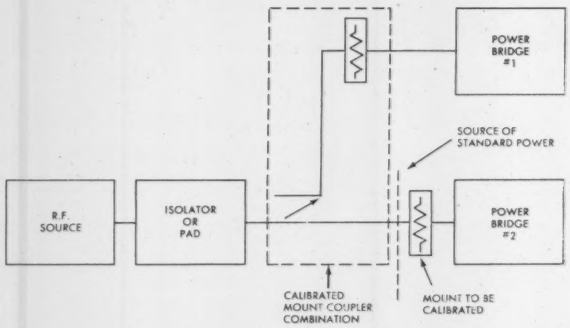
Scientific Instruments

2 Sheffield AVE.
Newport, Rhode Island U. S. A.

CIRCLE 65 ON READER-SERVICE CARD

R. F. Power Bridges

Microwave power measurements at power levels in the range below about 20 milliwatts are usually made using bolometers (thermistors or barretters) in arrangements, usually bridge circuits, which allow DC or audio frequency power to be substituted for R.F. power . . . The bolometer element is used as one arm of a bridge and the low frequency AC through the bolometer used to adjust the bolometer resistance to produce a bridge balance . . . Bolometers used in R.F. power measurements fall into two categories, thermistors and barretters . . .



The errors associated with the bolometer and its mount are usually lumped together and expressed as a calibration factor . . . Most commercially available power bridges are of the self-balancing variety and employ both DC and AC in their bolometer biasing circuits and as substitution power. For highest accuracy, however, both bias power and substituted power should be pure DC . . . (*From new 12-page Brochure "Power Bridges and Thermistor Mounts," Weinschel Engineering, Kensington, Md.*)

FOR THIS LITERATURE CIRCLE 236 ON READER-SERVICE CARD

Analog Multiple-Divider

An inexpensive computing device, designated MD-1, executes the operation $D = AB/C$ with an accuracy better than 0.1%. Since the parameters A and C are completely isolated, and may differ in form from the parameters B and D, ac and dc signals may be mixed in the computation with no loss in accuracy.

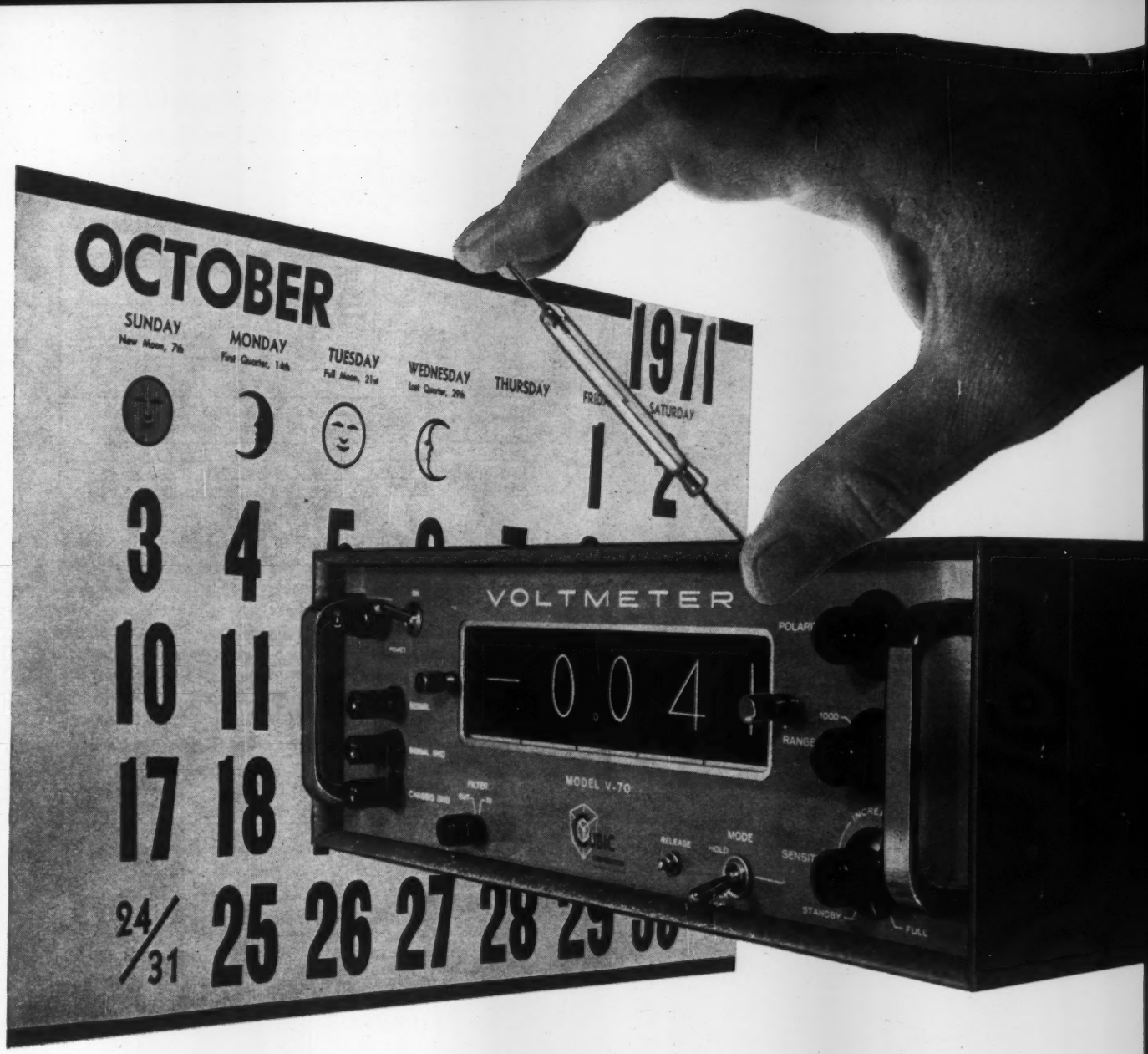
The computation element is an array of solid state resistors set up in bridge circuits. These resistors act as pure ohmic elements capable of carrying ac or dc currents. A dc control signal is applied so as to modify the values of the resistors to unbalance the bridges of which they are a part . . . The dc output of the power amplifier provides the control power which changes the ohmic values of the bridge resistors. It is available as a vacuum tube or solid state device. A high output impedance is helpful in extending the bandwidth of the multiplier, since changing of the bridge resistors is primarily a function of control current . . . The bandwidth of the system is easily extended by suitable amplifier design, and by insertion of equalizer networks in the null loop.

The multiplying element is only 2½" x 2¼" x 2¾" . . . (*From new brochure, ELASCO, Inc., 5 Prescott St., Roxbury 19, Mass.*)

FOR THIS LITERATURE CIRCLE 237 ON READER-SERVICE CARD

(*Continued on page* 1836)

CIRCLE 66 ON READER-SERVICE CARD ⟶



10 years without periodic maintenance!

The reed relays in the new Cubic V-70 series of digital voltmeters assure you of a decade of flawless service. These relays (which replace the stepping switches used in conventional DVMs) have been life-tested for 100 million operations—the equivalent of over ten years of normal operation. The V-70 covers the full DC range from 1 millivolt to 999.9 volts. Balance time is 500 milliseconds; maximum readout time, 750 milliseconds; absolute accuracy is 0.01% plus or minus 1 digit. The meter has no vacuum tubes or moving parts; it operates in any position and is heat and shock resistant; the relays require no maintenance. The V-70 series offers the highest operating speed available in its price range: V-70, only $1,580; V-71 (with automatic ranging and polarity), $2,200. For further information, write to Department IC-109.

cubic CORPORATION

INDUSTRIAL DIVISION
SAN DIEGO 11, CALIFORNIA • ROME, ITALY

OTHER OFFICES: LOS ANGELES, CALIFORNIA—ROME, ITALY (CUBIC EUROPA S.p.A.) • REPRESENTATIVES IN PRINCIPAL U.S. AND CANADIAN CITIES

Proven
ABSOLUTE PRESSURE CONTROLS

J20

by UNITED ELECTRIC

The Type J20 Absolute Pressure Control with its spring loaded, completely evacuated bellows provides positive switching . . . in response to source pressure variations . . . independent of atmospheric pressures and temperatures.

Pressure Range	0 to 35 psia
Adjustable Range	5.0 psia
Adjustments	factory calibrated at mid-point of the 5.0 psia adjustable range specified
Differential	factory set anywhere within limits of 1.5 to 5.0 psia
Repeat Accuracy	0.1 psia between −65° F to 160° F, altitude to 60,000 feet, 100% relative humidity
Switch Ratings	4 amps with non-inductive load of 28 volts D.C. or 10 amps at 115 volts A.C.
Switch Types	single-pole, single-throw, snap-acting class R—NC—opens on decreasing pressures class G—NO—closes on decreasing pressures
Electrical Connections	solder terminals on face of control can be pivoted and soldered in any position
Mounting	⅛" NPT, male thread to pressure source
Weight	approx. 5 ounces
Size	$3\frac{5}{32}$" x $2\frac{11}{32}$" x $1\frac{3}{32}$"
Applications	pressuring pumps on air-borne, mobile, or other equipment also in pressurized coaxial cables, in ground radar, and in maintaining frequency bands

UNITED ELECTRIC *manufactures a complete line of temperature, pressure and vacuum controls. Standard units can be modified or custom-built units made to your specifications. Additional information on pressure and vacuum controls is available upon request.*

UNITED ELECTRIC

CONTROLS COMPANY

85 School St., Watertown, Mass.

CIRCLE 67 ON READER-SERVICE CARD

Low-Temperature Metallizing

Low temperature metallizing falls into three categories: Metallize 'A': A silver-glass frit process that is used for unglazed and glazed steatite, and glazed alumina . . .

	STEATITE		ALUMINA
	ALSIMAG 35	ALSIMAG 645	ALSIMAG 576
PROPERTY	High strength insulators with good electrical characteristics, made to close tolerances for household equipment and appliances.	Good mechanical and electrical properties. Especially suited for complicated pressed pieces.	An economical high strength alumina with excellent electrical and mechanical characteristics. 85% Al_2O_3
Water Absorption %	0 to .02 Impervious	0 to .02 Impervious	0.00 Impervious
Specific Gravity	2.5	2.7	3.4
Density Lbs. per cu. in.	.090	.098	.123
Standard body colors[a]	White	White	White

Metallize "B": A direct soldering silver-glass frit composition that is used on unglazed or glazed steatite and glazed alumina that can be soldered directly . . . Metallize "R": A modified silver base process that is used primarily for unglazed ceramics . . . *High temperature metallizing* falls into two categories; the active metals method and the refractory metal powder method . . . (*From new 16-page Bulletin 612, American Lava Corp., Subs. of Minnesota Mining and Mfg. Co., Chattanooga 5, Tenn.*)

FOR THIS LITERATURE CIRCLE 238 ON READER-SERVICE CARD

Statement of Ownership, etc.

Statement required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933, July 2, 1946 and June 11, 1960 (74 Stat. 208) showing the Ownership, Management, and Circulation of

INSTRUMENTS & CONTROL SYSTEMS
published monthly at Pontiac, Illinois for September, 1961.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Richard Rimbach, 8550 Babcock Blvd., Pittsburgh 37, Pa.; Editor, Milton H. Aronson, 4800 Stanton Avenue, Pittsburgh, Pa., Managing editor, F. D. Marton, 209 Gilkeson Road, Pittsburgh, Pa.; Business manager, Richard Rimbach, 8550 Babcock Blvd., Pittsburgh 37, Pa.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member ,must be given.)

Richard Rimbach, Sr., Pittsburgh, Pa.; Mrs. Richard Rimbach, Pittsburgh, Pa.; Richard Rimbach, Jr., Pgh., Pa.; Mrs. M. F. Behar, New York, N. Y.; Milton Aronson, Pgh., Pa.; Martha Rimbach, Pgh., Pa.; Gretchen Rimbach, Pgh., Pa.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown was: (This information is required by the act of June 11, 1960 to be included in all statements regardless of frequency of issue) 31,221.

Richard Rimbach, Publisher.
Sworn to and subscribed before me this 25th day of September, 1961.
(SEAL) John T. Roscher.
(My commission expires Feb. 6, 1963)

HOW FAR . . . AND HOW FAST . . .

can you use computer control *profitably?*

BAILEY 700 SYSTEMS CAN HELP YOU DETERMINE THIS—ONE STEP AT A TIME

Can computer control be used—profitably—in your process operations?

Where and how?

The answer often lies in intermediate stages of improvement in sensing, measuring, controlling, computing.

Bailey engineers can help you determine and prove — one step at a time — how far analog or digital systems can be profitably applied in your operations. Bailey is equipped, by broad experience, to provide single-source responsibility from sensing and measuring instrumentation to complete automation. *Bailey 700 Systems* are installed, in operation, or on order, at locations from coast to coast and throughout the world.

Find out what this Bailey background can offer. Contact your Bailey District Office.

SIX STEPS TO FULL AUTOMATION

Centralize and simplify information display—use analog and digital techniques to clarify information, aid operator understanding, improve reliability of interpretation, and save space.

Extend use of interlocks and limiting circuitry—use digital solid-state components to extend supervisory controls, thereby minimizing effects of human error.

Increase use of automatic sub-loops—simplify and standardize the starting, controlling, and stopping of major plant components and sub-systems.

Extend on-line controls—integrate sub-loops, interlocks, and limiting controls with conventional controls to secure automatic operation over full range, once unit is on the line.

Provide performance monitoring—add computing facilities to provide significant up-to-date calculations for operation improvement and maintenance scheduling.

Integrate all system elements—add start-stop control to provide full automation, the ultimate goal.

G 158-1

INSTRUMENTS, CONTROLS, AND SYSTEMS

BAILEY METER COMPANY

1041 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

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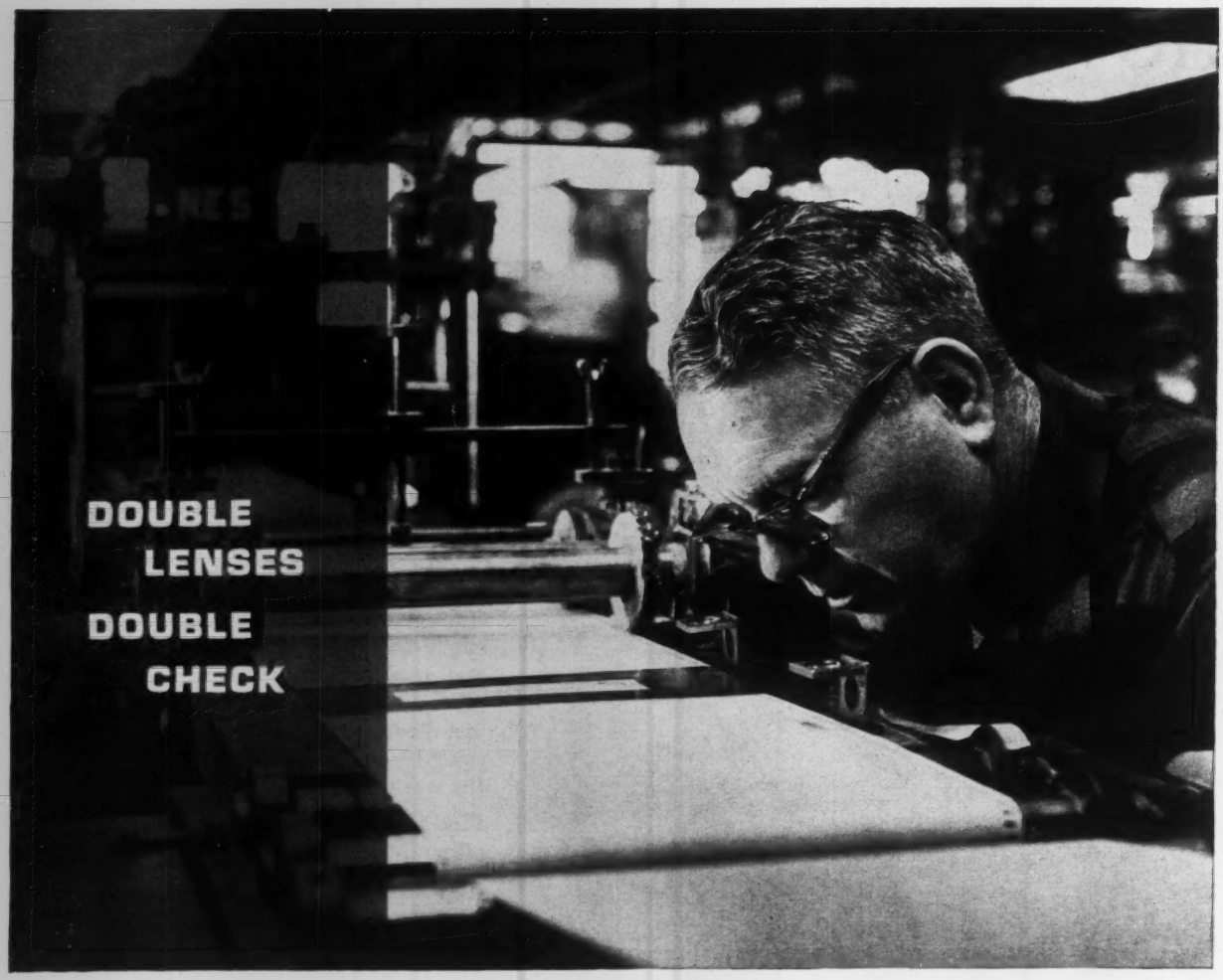


. . . for the precise calibration that means RECORDING CHART DEPENDABILITY

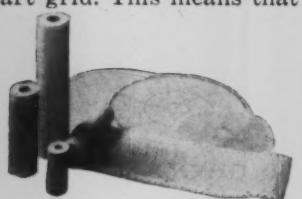
Charlie Robinson, our pressroom supervisor, is making a careful chart calibration check in the picture above. He does this often.

To make this test Charlie uses two engraver's glasses, a special templet . . . and the 50 years of chart printing experience that stands behind every GC Recording Chart.

What this test involves is making sure that the center line of the circular punches on a GC Strip Recording Chart is always the same distance — the *correct* distance — from the zero line of the chart grid. This means that a 25 psi recording at the end of a process, for example, will have the same value as a 25 psi recording at the start.

Take rigid inspection standards like these — and add repeated paper and ink tests, continuous humidity control in production and storage areas, and speed of printing and delivery. You'll see why more than 5,000 chart users rely regularly on GC dependability.

GC stocks more than 15,000 different chart types. We design and print charts for special purposes. Why not send now for the GC Stock List and for specific sample charts?



RECORDING CHARTS

TECHNICAL RECORDING CHART DIV.
GRAPHIC CONTROLS CORPORATION
189 Van Rensselaer St., Buffalo 10, N.Y.

CIRCLE 69 ON READER-SERVICE CARD

PANHANDLE PETE

WESCO! PLUGS HOLE IN DEFENSE POSTURE

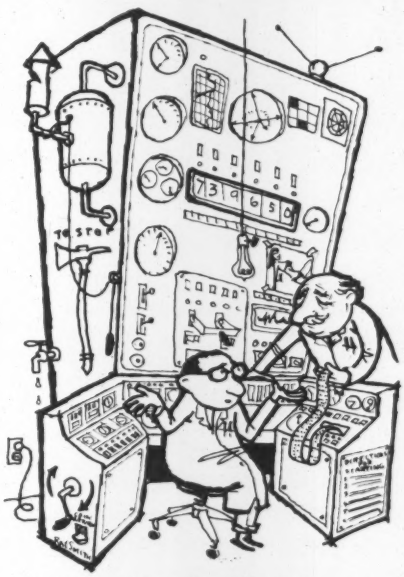
An obvious and dangerous hole in the nation's defense posture has been plugged by WESCO!, the company whose motto is Progress Through Enlightened Instrumentation. While our country has been spending $45 billion a year preparing for nuclear war to defend our freedom, and $0.5-million for civil defense to defend our citizens, no thought has been given to the fact that the critical heart of our industrial civilization, the instruments and computer-controllers that control our complex industrial complex, the instrumentation without which no modern industrial state can operate—all these vital elements are sensitive to nuclear blast, fire, and fallout. This oversight and weakness in our society has been eliminated by that far-sighted firm—WESCO!—which announces the country's first complete line of falloutproof instruments.

No more need an industrial manager worry about what will happen when the bombs fall. WESCO! instruments have been made fallout proof by shielding all dynamic and passive elements susceptible to environmental radioactive influences (AN contract 47635925, Project Survival). In most instruments (such as the WESCO! three-loop process control computer) this meant encasing all sensitive elements in 18 layers of tungsten-rhubidium-platinum-lead shields, sandwiched by temperature controlled recirculating water.

Special problems were encountered with the WESCO! Kanarienvogle gas analyzer, which did not function properly with 142 pounds of shielding. However, after 8 months of intensive research (An Contract 345672-91-48, Project Kanarienvogle Waffensinking Under Wasser) a solution was found by encasing only the Kanarienvogle gonads, testes cerebri, and inferior colliculi of the corpora quadrigemina with a specially designed shield of platinum-lead-rhenium (AN Project 47893942, Project Kanarienvogle Ballsenstuffensaven).

Every instrument in the WESCO! large line now can be offered in special fail-safe and fallout-proof versions (at slight additional charge). All instruments have undergone field tests, and satisfaction is guaranteed or money will be returned if any instrument fails due to nuclear holocaust—instrument must be returned by original purchaser.

Panhandle Pete



The "punch line" for this cartoon was lost by Panhandle Pete. This provocative situation might suggest a fitting caption to our imaginative readers. Ten dollars worth of our books or Handbooks will be sent to any (and all) readers who suggest a fitting caption. Test of "fit" will be publication in the December issue.

Digital Techniques for Computation and Control	**$4.00**
Electronic Circuitry for Instruments and Equipment	**$2.00**
100 Electronic Circuits—Vol. 1	**$2.00**
100 Electronic Circuits—Vol. 2	**$2.00**
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INSTRUMENTS PUBLISHING CO.
845 RIDGE AVENUE
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NEW!
Heat-sensitive
RECORDING CHARTS
Quality-Proven in Test after Test!

After lengthy research and extensive testing, GC brings you the best all purpose heat-sensitive oscillograph paper for a wide range of recorders and every industrial application.

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Through volume production, and with over 50 years of experience, the world's largest producer of recording charts can bring substantial savings to you for all your chart requirements.

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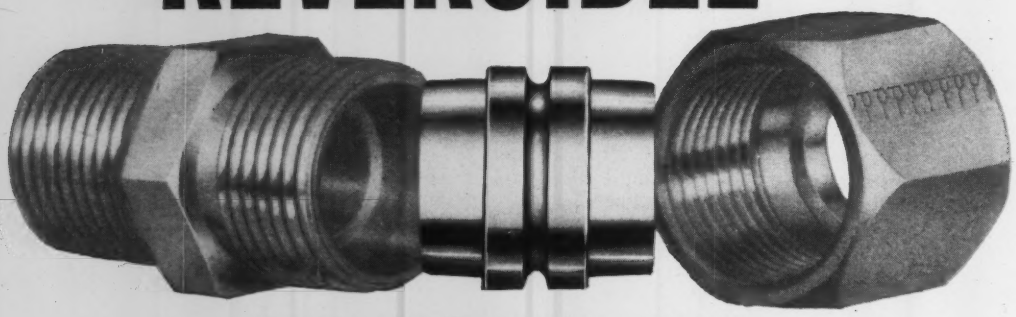
PARKER "RIDG-LOK®" REVERSIBLE



FERRULES TAKE THE GAMBLE OUT OF COMPRESSION FITTINGS ASSEMBLY

ONE DESIGN

IN STAINLESS STEEL, BRASS, MONEL AND STEEL; FOR USE WITH STAINLESS STEEL, COPPER, MONEL OR STEEL TUBING.

Special Teflon ferrules available for use with glass tubing.

Ferrules have always been the bane of compression fittings. Take a fitting apart and the ferrule either gets put back or it doesn't . . . if it does get put back, it either gets in the right way or in backwards, or "cocked." Some compression fittings have *two* ferrules. Then the odds are really against you.

Parker's new compression fitting, "Ridg-lok," ends all that. Its ferrule has identical ends. Either way it gets put back is the right way. And the end that doesn't grip the tube protrudes through the nut. You're sure the ferrule got put back, straight, because you can see it.

PARKER HANNIFIN CORPORATION

PARKER-HANNIFIN

Parker FITTINGS AND HOSE DIVISION
17325 Euclid Avenue • Cleveland 12, Ohio

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

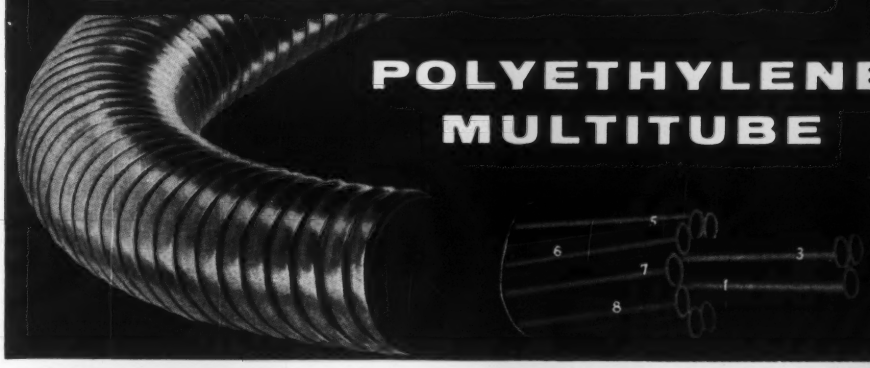
3582-PH EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS

CIRCLE 70 ON READER-SERVICE CARD

CRESCENT

POLYETHYLENE MULTITUBE

VALUE



with INDIVIDUALLY NUMBERED TUBES

INDIVIDUALLY NUMBERED TUBES—Numbers in white appear at 2-1/2" intervals throughout the length, thus permitting positive identification of every tube anywhere along the length, as well as at each end.

BLACK POLYETHYLENE TUBES—Pigmented, high molecular weight virgin polyethylene Type P tubes are employed for maximum resistance to environmental stress cracking and aging in sunlight.

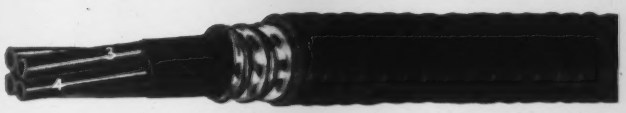
THREE STANDARD TYPES TO MEET YOUR SPECIFIC NEED

CRESCENT POLYETHYLENE MULTITUBE is composed of 2 to 37 individually numbered black Type P Tubes, cabled together under a heavy, waterproof PVC tape with a flexible, interlocked, galvanized steel armor for complete mechanized protection. A polyvinyl chloride (PVC) sheath can be furnished over the steel armor for permanent protection from the weather and any corrosive exposure.

STANDARD TYPES

TYPE PA—Interlocked metallic armor provides complete mechanical protection to the inherently corrosion resistant tubing.

TYPE PAT—Polyvinyl chloride sheath over the armor adds corrosion protection for the armor. Can be buried in the earth.



TYPE PT—PVC sheath gives limited mechanical protection. For use in troughs, trays or conduit.

CRESCENT POLYETHYLENE PRECISION INSTRUMENT TUBING—TYPE P developed through extensive research, improved manufacturing methods and rigid test standards, will continue to be available in 1/4", 3/8" and 1/2" OD sizes in up to seven bright colors and black for use as single tubing behind panels and in MULTITUBE when specified.

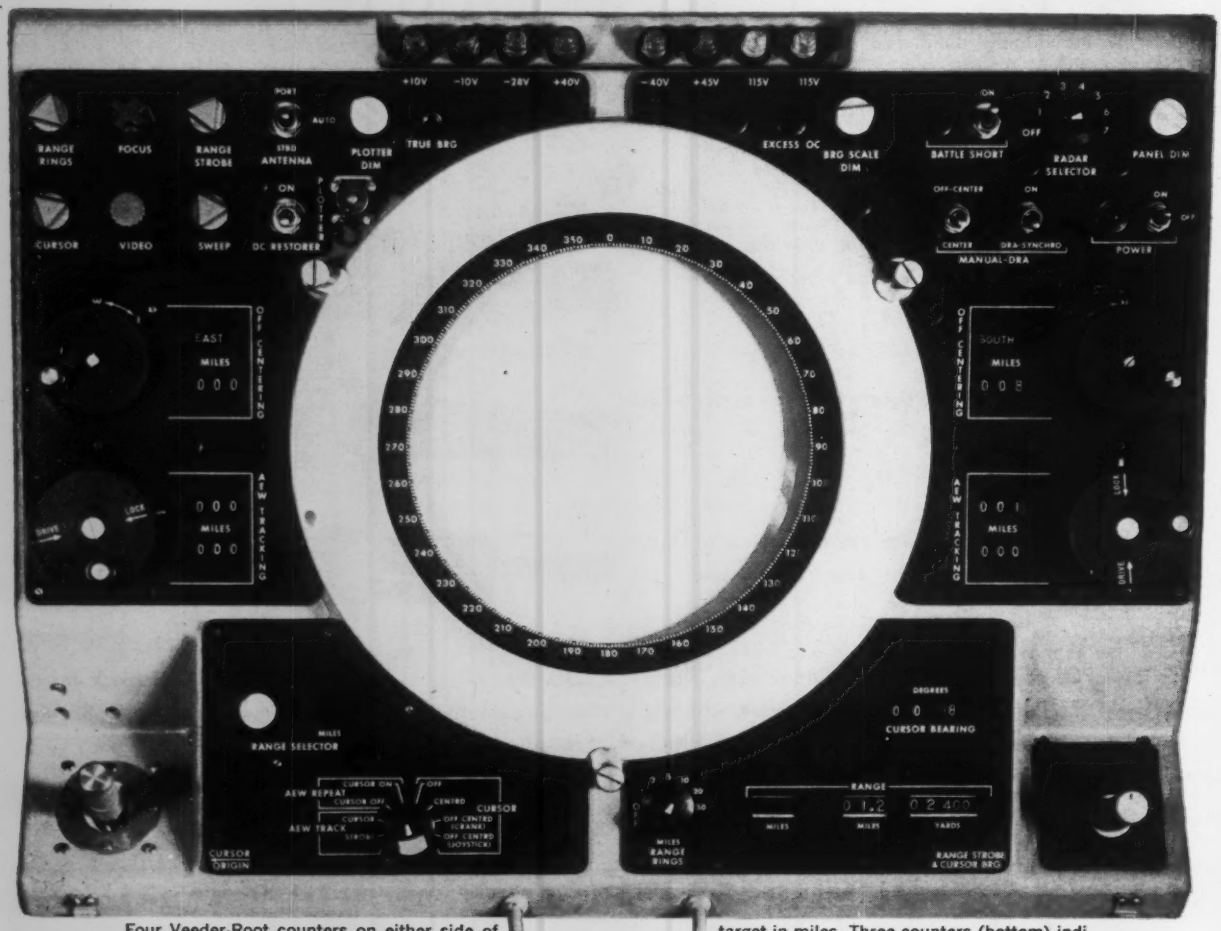
WRITE FOR BULLETIN NO. 960-A

CRESCENT INSULATED WIRE & CABLE CO., INC.

TRENTON, NEW JERSEY

CIRCLE 71 ON READER-SERVICE CARD

What!—counters for radar reading? To give the Navy vital facts fast, Philco builds counters right into radar control panels. These direct readout counters were designed by Veeder-Root to eliminate dials and manual interpretation of instrument data—make radar reading easier than ever. Find out how Veeder-Root can help you simplify your operations. Write to Instrument Section, Veeder-Root Inc., Hartford 2, Conn. **count on . . . VEEDER-ROOT**



Four Veeder-Root counters on either side of screen tell radar operator exact location of target in miles. Three counters (bottom) indicate angle and range in miles and yards.

CIRCLE 72 ON READER-SERVICE CARD

EDITORIAL

THE 16th Annual Instrument-Automation Conference and Exhibit was held September 11-15 in Los Angeles. The Conference was held in the Biltmore Hotel, and the Exhibit in the lovely new Los Angeles Memorial Sports Arena.

The major impression, in both Conference and Exhibit, was that 1961 is a year of "catching up," of consolidating and refining the technological breakthroughs that characterized the past several years. Not every year can see the "world's first process control computer," although the "first pneumatic process control computer," was debuted at the Show by AiResearch.

The theme of the Conference, "Reliable Information From Undersea to Outer Space," is always appropriate in a general way. Instrumentation is a horizontal art and science; instruments are used not only from undersea to outer space, but in every realm and all levels of organized activity. Instruments are found everywhere today, as the 280 papers showed.

The greatest interest, conference-wise, seemed to be in measurements, standard activities and analysis instrumentation.

Since the earliest days of instrumentation, a serious problem has been where to place the instrument activity—should it be in production because it serves the production line? Should it be in engineering because it is engineering in nature? Should it answer directly to management because it serves the plant horizontally?

The problem has no one answer. Instrumentation is used in research, in engineering, in production and in management functions of any large organization. Experience has long established the fact that instrumentation responsibility should not be left entirely to the end user—the individual researcher or engineer or production man. The importance and complexity of instrumentation demands a specialized facility. Such a facility can function as instrument storehouse, calibration center, standards activity, and consultant in matters pertaining to instrumentation. This has been the trend in industry—but only a beginning has been made.

Many papers and sessions were devoted to establishing the costs and economies of instrumentation. Bill Wildhack of the National Bureau of Standards rephrased the cost problem by asking "what is the cost of inaccuracy?" and pointed out that instrument facilities trying to establish their cost pictures might be able to establish the cost of not having proper accuracies, and thus emphasize their value to management.

Among the new products of interest at the exhibit in California were the following:

1. Minneapolis-Honeywell introduced a new Tel-O-Set line of "loop building blocks" (all based on 4-20-milliamperes output), including adder, subtractor, integrator, multiplier/divider, ratio/variable cascade, square root, signal delay, 1-mode controller, limit stop, I/I transducer, ΔI/P transducer, MV/I transducer, etc.—making possible "instant systems." M-H also introduced a new test and calibration console for testing the complete line of Electrik Tel-O-Set instruments.

Daystrom (Weston Division) entered the field of continuous stream analysis with the "Indexometer" refractometer.

Electronic Associates unveiled its new Process Control Computer, using analog-computer elements to solve the desired process-control problem.

Fischer & Porter unveiled new potentiometer recorders featuring plug-in modularized design that makes servicing of even the potentiometer servo element a simple matter of plug-in replacement. F&P also had a fine display that showed the extreme accuracy of its new digital blending system.

Bailey Meter featured a new automatic burner light-off system, a subloop that is essential to the "automatic plant."

Data Sensors unveiled a new linear accelerometer with 5-v output (10-v excitation) using new photoresistive principle.

Beckman showed its new EASE analog computer and the new 210 high-speed data processing system.

Moore Products featured a new "Optimizer" that senses the peak of a process reaction and keeps control at the peak—pneumatically.

Presin unveiled a tiny pendulum-principle pulser that gives pulses at 4 to 10 pps at stability of 30 ppm/day—at a price of $17.50!

Foxboro unveiled a new electronic impulse-duration system using a light-sensitive diode in the transmitter; also the new Foxboro-Waugh blending system.

Big news in the process-control-computer field was, of course, the new IBM 1710 control system for processes (using an IBM 1620 Data Processing System) and the GE 412 Process Control Computer.

Dynel (Varec) unveiled the new Dynacode telemetering system for remote reading of level, pressure, etc.

Borg-Warner showed a new line of electronic test instruments—VTVM, VOM, RF Power, etc.

Soroban showed its new high-speed punched-tape reader using anemometer (air pressure sensing.

General Controls showed the world's smallest (¾") motor-operated gate valve for industrial use, also a dual Hydramotor valve actuator.

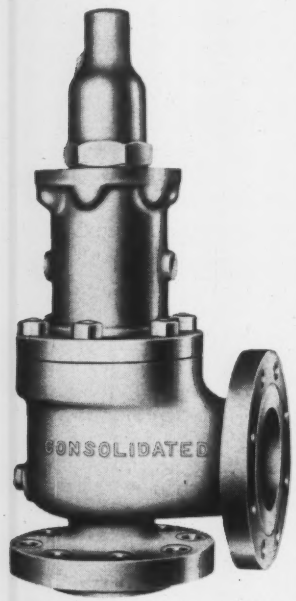
Martin-Decker unveiled its pressure calibrator, using test gauges and dry nitrogen source of pressure.

NESCO (Newport Scientific Co.) introduced a 0.5%-accuracy, 0.5-second speed potentiometer recorder with Zener reference—at less than $600!

seal

CONSOLIDATED SAFETY RELIEF VALVE'S Sealing Bellows protects against damage from contaminants, corrosion, or viscous fluids

saves



Consolidated Safety Relief Valves are available in both Balanced Bellows and Standard designs. The Standard type has an eductor tube that effectively removes bonnet pressure.

Balanced Bellows Type Consolidated Safety Relief Valves have a durable, two-ply stainless steel Sealing Bellows that isolates and protects working parts from destructive elements in the lading fluid.

The bellows is balanced with the seating surface. Even with superimposed back pressure in the relieving system, valve performance is consistently stable and dependable. The bellows does not affect the high capacity of the valve, nor does it require change in set pressure. Even the blowdown adjustments are limited.

Additionally, Consolidated Safety Relief Valves now offer a no-leak tightness maintained by a resilient "O" Ring Seat Seal retained in the valve disc. This Seal assures tightness at operating pressures far closer to set pressure than with metal-to-metal seats alone, yet does not carry the seat load imposed by the spring. The Seal also takes piping strains much better than all-metal seating.

The Sealing Bellows and "O" Ring Seat Seal are typical of the extra quality built into Consolidated Safety Relief Valves to assure absolute protection for personnel and plant. These fine features plus flat seating and single ring construction also eliminate many maintenance problems and costs. Write for Catalog 1900 and Bulletin 1940.

MANNING MAXWELL & MOORE INC. TRADE MARK

CONSOLIDATED SAFETY RELIEF VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Valve Division • Tulsa, Oklahoma

Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario
Latin America: Export Division, Chrysler Building, New York, N. Y.
Europe: Manning, Maxwell & Moore, S. A., Fribourg, Switzerland

CIRCLE 73 ON READER-SERVICE CARD

FRED MARTON
Instruments Publishing Company

BALL VALVES

BALL VALVES are at present about a $15-million segment of the $1.5 billion valve market—but this segment is expected to increase more than five times before 1964. Advantages claimed for the ball valve over more common types (gate, globe, tapered plug, etc.) include less friction, space saving and bubble tightness. C_v ratings (taken from bore size rather than nominal valve size) compare favorably with other type valves.

There are two basic types of ball valves, each of different design—the *pierced ball* (which is turned on or off by a quarter turn of the ball) and the *movable ball** (in which the ball moves up or down and seats itself against a seat).

Seats usually are made of Teflon for corrosion resistance and low friction against the ball. Some models offer rotating seats to reduce wear further.

Sizes from ⅛″ to 42″ are offered by about 25 manufacturers, with pressure ratings as high as 10,000 psi, as follows:

*Only one manufacturer offers the solid-ball type; unless stated, therefore, the term "ball valve" is used in this article refers to the pierced-ball type.

American Chain & Cable Co. R-P & C Division

American Chain and Cable (Fig. 1) offers the Fig. BL-300, made in sizes ¼″ to 2″ by R-P & C Div. The valves are equipped with "auto-mating" seats to insure positive sealing in either flow direction, making it useful for vacuum service. The pierced ball, machined to ball-bearing accuracy is, like the stem, made of naval bronze.

Ball Valves, Inc.

Ball Valves, Inc. manufactures hand-operated SMITH pierced ball valves (Fig. 2). The SMITH F-400, made of forged naval bronze, with "Auto-Mating" Teflon seats, provides positive sealing. Sizes are from ¼″ to 2″. Pressure ratings are from vacuum to 400 psi.

Cameron Iron Works

Cameron Ball Valves feature rotating seats (Figs. 3 and 4). The seats on the upstream and downstream

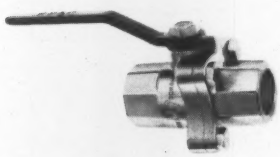


FIG. 1. AMERICAN CHAIN & CABLE'S R-P & C Division features naval bronze for valve body and ball.

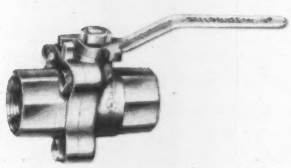


FIG. 2. BALL VALVES, Inc.'s SMITH valves are suited for vacuum service.

FIG. 3. CAMERON valves feature rotating seats.

side of the pierced ball are caused to rotate a fraction of a turn each time the ball is opened. Seat wear is concentrated at the point where flow is initiated on opening the valve or pinched off in closing, and rotation of the seats distributes this wear over the entire seat area. This results in tight shut-off and greatly increases seat life.

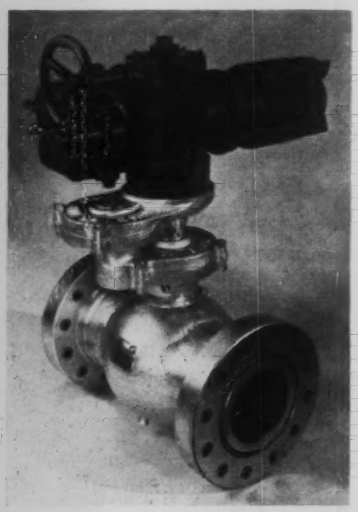


FIG. 4. ELECTRIC-MOTOR actuator with Cameron Valve.

Sizes are 2″ through 42″, pressure ratings 150 psi ASA through 1500 psi ASA, with screwed, flanged, or welding ends.

Any established make of electric, hydraulic, or pneumatic quarter-turn power actuators can be used.

Cooper Alloy Corp.

Cooper Alloy offers pierced ball valves in sizes from ½″ to 2″ in six variations, and a brand new line of miniature valves from ⅛″ to ½″ (Fig. 5).

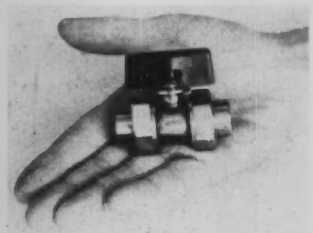


FIG. 5. COOPER miniature line comprises sizes 1/8" to 1/2".

Operation of these valves is manual or by cylinder or electric-motor operators (made by others).

Crane Company

Crane has a new line of pierced ball valves (Fig. 6) in bronze, steel and stainless steel and in sizes from ¼″ to 2″, rated from vacuum to 800 psi and from —40 to 400°F.

Valves feature Teflon seats with controlled preloading. Another design feature is the tapered cartridge which contains the entire seating assembly, facilitating removal from the line for cleaning. Reassembly of the cartridge is simple and its design assures accurate replacement in valve body. "O"-ring seals on both stem and cartridge insure proper closure, and a Teflon thrust washer between the stem and retaining ring compensates for axial stem thrust due to line pressure keeping stem friction at a minimum.

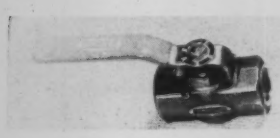


FIG. 6. CRANE features a removable cartridge containing the entire seating assembly.

General Kinetics Corporation

General Kinetics Corp. manufactures two types of ball valves: the Hi-100® Industrial Control Valve (formerly called the P-K Paul® Valve) and the Ludeman Rotoflo® Valve.

The Hi-100 Valve (Fig. 7) is a solid ball-valve (where the ball takes the place of the plug in control valves, in contrast to pierced-ball valves) designed primarily for industrial control applications. Its outstanding features are: (1) high flow capacity (C_v's from 1.0 for the ¼″ size to 3920 for the 14″ valve); (2) wide rangeability (up to 200:1); (3) ability to handle large pressure drops, high velocities, and extreme temperatures; and (4) tight shut-off (with "lower operating thrust than other single-seated valves").

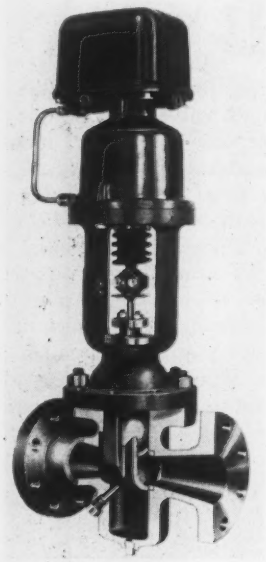


FIG. 7. GENERAL KINETICS' Hi-100® valve (formerly called the P-K Paul® valve) has solid ball held in a cage which is moved by stem. When valve is opened, cage lifts ball up and simultaneously rolls it away from seat.

The ball is held in a cage which is moved by the stem. When the valve is opened, the cage lifts the ball up and simultaneously rolls it away from the seat.

The *Ludeman Rotoflo Valve* (Fig. 8) is a pierced-ball valve that differs from the conventional ball valve in two important respects: (1) An eccentric cam lifts the ball away from the seat before it starts to turn. As there is no friction between the spherical plug and the seat, the valve handles abrasive fluids and can be used at high pressures. (2) Metal-to-metal seating permits the valve to be used at high temperatures; locking action assures tight shut-off under all conditions. Elimination of the soft plastic seat used in conventional ball valves makes this valve especially suitable for shipboard use (fire does not cause failure), nuclear

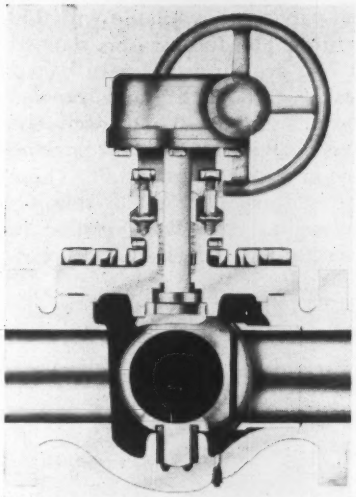


FIG. 8. LUDEMAN ROTOFLOW valve made by General Kinetics features eccentric cam that lifts ball away from seat before it starts to turn.

installations (seat does not deteriorate from radiation); and cryogenic applications; as well as high temperature and high pressure service.

Hills-McCanna

Hills-McCanna makes pierced ball valves of both the top-entry ("McCannaseal") and the bar-stock ("McCannaflo") type hand-operated or with pneumatic or electric actuators.

The valves (Fig. 9) feature "wedge-seat" design that automatically adjusts for wear and top entry for easy maintenance. Ball and seats are spring loaded and move down into the wedge when wear occurs. Flanged Type S-151 is rated 150 psi; Type S-301 has 300-psi rating. Sizes 1" through 8" have C_v values from 27.5 to 2100. Screwed-end Type S-2 and socket-weld Type S-3 have 300 psi rating. Cast and wrought bodies, and trim are made of carbon steel, stainless steel, bronze, aluminum. Sizes: 1" through 3" with C_v values from 27.5 to 248.

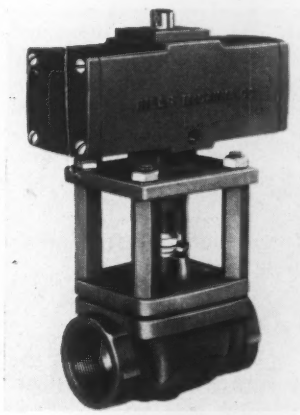


FIG. 9. HILLS-McCANNA McCannaseal type.

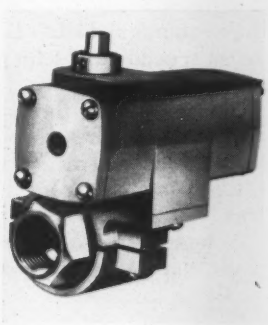


FIG. 10. McCANNAFLO-TYPE valve with top-mounted pneumatic operator.

McCannaflo design (Fig. 10) features prestressed, non-flexing seats for leaktight closure. Made with screwed ends in ¼" through 2" sizes, up to 1000-psi rating; and flanged, ½" through 2", 150 and 300 psi.

Pneumatic actuators are made in two types: Bonnet-mounted, double-action piston actuators (Models S-1, S-1½", or 2" size); and U-bolt mounted cylinder-and-lever actuators for McCannaflo valves of all available sizes (Models 2129-size).

For larger-size top-entry valves, bonnet-mounted double-acting piston operators (Models 301 for 3"; 701 for 4"; 2701 for 6"; and 732 for 8") are made.

Electric operation is via solenoid-valve control of air supply to pneumatic valves.

Hoke, Incorporated

Hoke specializes in making plastic ball-valves (Fig. 11). The toughest grade of type I unplasticised polyvinyl chloride is used. The valves are suited for ex-

FIG. 11. HOKE offers plastic ball valves up to 3" size.

tensive chemical service, are dimensionally stable, and feature high impact strength. Self extinguishing and almost completely non-aging, the valves can be heat welded or solvent bonded directly in the line. They have Teflon seats and are leak-tight at the seats and at the stem. With a pressure rating of 125 psi and temperature rating of 125°F, the valve body has a tensile strength of 8500 psi. Catalog numbers 2672 to 2677 range from ½"-NPT to 3"-NPT connections on both ends. A coupling-like assembly simplifies installation, eliminating need for adapters and fittings.

Homestead Valve Mfg. Co.

Homestead (Fig. 12) offers hand-operated pierced ball valves with cast or barstock bodies, featuring flexible self-forming Teflon seats which require no lubrication.

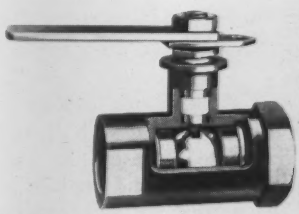


FIG. 12. HOMESTEAD bar stock valves feature field-interchangeable ends.

Cast in bronze or semi-steel in sizes ¼" to 4" in straight-way type and three-way type, made from brass, steel, or stainless steel bar-stock, they have threaded, flanged, reducing, socket, etc. ends which are interchangeable in the field. No unions are needed, as the valve ends act as unions. Valves are designed for handling fluids at 175 psi or 400 psi, oil, water, gas.

Air and electric actuators are available for all sizes and types.

Gordon Hurst, Inc.

HI-FLO Valves feature a supported ball (Fig. 13). The stems of the ball are supported in the case which is split on a 45-degree angle.

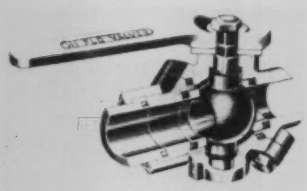


FIG. 13. HURST offers supported ball feature.

Valves can have one end threaded and union on other end. Valves are available in pressure range to 6000 psi.

Air or hydraulic actuators can be directly connected to the valve without external linkage. The actuators are fully enclosed, free from contamination. Electric motor actuators are also available for 110-220--volt and 12-volt service.

Hydromatics, Inc.

Hydromatics FLO-BALL Valve line (Fig. 14 and 15) features top entry for in-line maintenance, top and bottom guided ball, double seats, end flanges integral

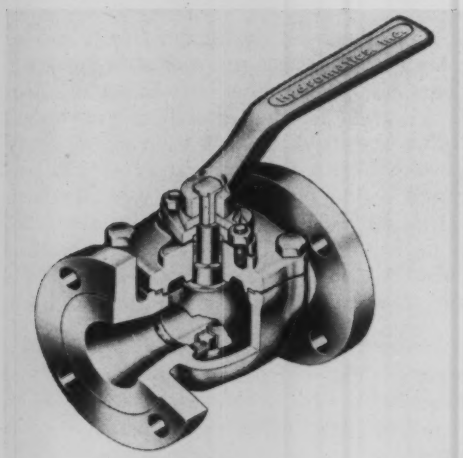


FIG. 14. HYDROMATIC'S FLO-BALL valves feature top-and-bottom guided balls.

with body, one-piece ball and stem and block and bleed. These features (1) make it possible to disassemble, remove, and replace any or all internal parts and reassemble without removing the valve body from the line; (2) put the pressure load on the ball into the top and bottom bearings eliminating distortion of the seats and providing longer seat left and easy operation; (3) insure sealing in both directions for double protection against leakage; and (4) give permanent perfect alignment with no backlash. Top and bottom guided ball and floating seats provide simultaneous upstream and downstream seal, making the valve a true block and bleed type.

Standard flanged end valves are available with 150 psi and 300 psi ASA ratings. The 150 psi ASA flanged valves, Series 701 and 711, are furnished with bolted packing glands in sizes 1″ through 8″, and screwed packing glands in sizes 1″ through 6″, respectively. The 300 psi ASA flanged valves have bolted packing glands and are available in sizes 1″ through 6″. These valves are standard with carbon steel and/or stainless steel (316) bodies and balls. Three-way versions of the 150 psi ASA flanged end ball valves are also available.

A bar stock Series 715 FLO-BALL Valve (Fig. 15) rated at 600 psi WOG, is made in sizes ¼″ to 2″, with

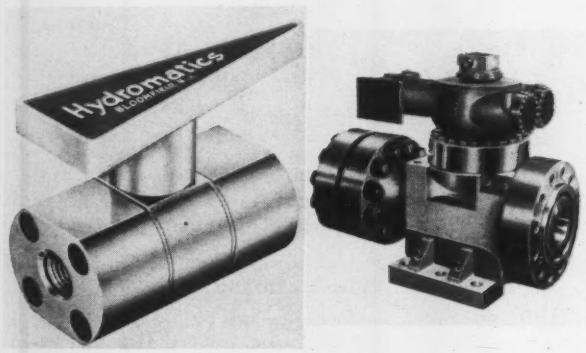


FIG. 15. HYDROMATIC'S bar-stock Series 712 (left) and Model 145 14" 5000-psi fast-response valve (right).

either NPT or AND threaded ends. These valves are standard in carbon steel, brass, Monel, and 303, 316, and alloy-20 stainless steel. A 3-way, Series 912, valve is also made.

The Series 715 FLO-BALL Valve is rated from vacuum through 3000 psi and is made in sizes ⅛″ through ½″ with NPT threaded ends, and in sizes ¼″ through ½″ with AND threaded ends. Standard construction materials are 303 and 316 stainless steel, brass and Monel.

Hydromatics, in addition to its standard off-the-shelf commercial FLO-BALL Valve line, has furnished many special valves for cryogenic services, automatic on-off and control installations, dual coupled propellant valves for the X-15 experimental rocket space ship, for pressures through 10,000 psi, and for pipe lines through 20-inch sizes.

C_v ratings are from 2 for ¼″ bore to 1050 for 14″ bore.

Actuators available include manual, electric, pneumatic, and hydraulic types.

Jamesbury Corp.

Jamesbury ball valves (Fig. 16) feature the "Double-Seal" principle for zero leakage. The floating ball with a round port through it is preloaded between specially designed seats which, in themselves, support the ball and are self-compensating for temperature, pressure, and wear. No lubrication is required.

Body materials are carbon steel, 3 types of stainless steel, bronze, ductile iron, Monel, aluminum and PVC.

Three types of valve actuators are available: (1) 7 models (Fig. 16) of cylinder (PC Series). For pneumatic or hydraulic actuation, 60-to-150 psig pressure

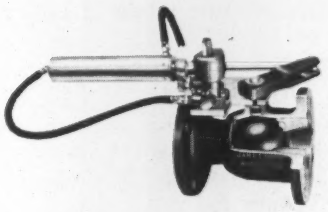


FIG. 16. JAMESBURY valves have floating ball between preloaded seats. Double-acting cylinder actuators for pneumatic or hydraulic service.

is required; all pneumatic or hydraulic operators are available with 4-way pilot valve or fail-safe spring return when required. (2) A line of 6 stationary pneumatic or hydraulic (ST-Series) is available. (3) Electric actuation (Fig. 17) is by Type EM25 for the small

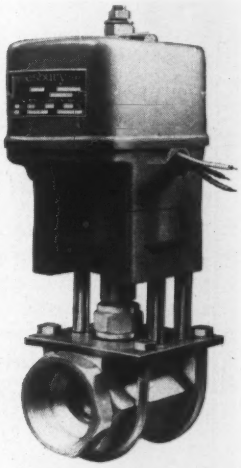


FIG. 17. ELECTRIC-MOTOR actuator for Jamesbury valves have a planetary gearing, operates on 115v/60c ac.

sizes through 2″, Type EM150 for valves of the 3″ and 4″ size, and Type EM-500 for 6″ and 8″ valves, of all types. In case of power failure they can be operated manually.

C_v ratings range from 8 for ¼″, ⅜″ and ½″ valves to 3500 for the 10″ size.

Lunkenheimer Co.

Stainless-steel valves (Fig. 18) made by Lunkenheimer are designed for corrosive service with fluids

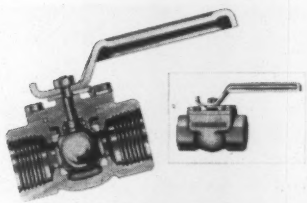


FIG. 18. LUNKENHEIMER stainless-steel valves are precision machined.

and gases and general use. They are manufactured to close tolerances, obviating the need for take-up maintenance (Teflon seats are precision molded and then machined to insure perfect mating between seat and ball surfaces). Thus, no internal springs or compensators are required.

The design features top entry, compactness, self-aligning ball, straight-through flow, long-lasting resilient seats and seals, quarter-turn operation, low-operating torque and leak-proof performance. Seat materials are Teflon (for temperature range −20° to 400°F) and Buna-N (for −20° to 220°F). Sizes available are ¼″ to 2″.

Clayton Mark & Co.

The Forged Steel Products Division of Clayton Mark & Co. manufactures the Petro ball valve (Fig. 19) of dual-seal design featuring a one-piece forging,

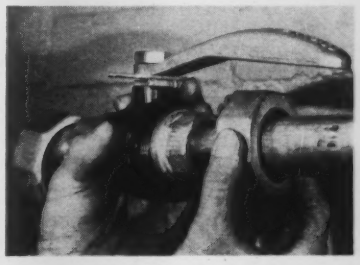


FIG. 19. CLAYTON MARK & CO. features ball valves with built-in union ends.

and built-in union ends, which simplify installation, operation, and maintenance. Available in Buna-N, Neoprene, and Teflon, the seats are interchangeable to meet most media requirements. Maximum pressure rating for all sizes of valves with Buna-N and Neoprene seats is 300 psi. Teflon seats are rated to 600 psi for 1″ through 2″ valves and to 1,000 psi for ¼″ through ¾″ sizes. It has completely contained "O"-ring seals whereby seal extrusion is prevented. Valve is available in stainless steel, carbon steel, or brass, and in eight sizes, ¼″ through 2″.

Pacific Valves, Inc.

Pacific ball valves feature straight-thru ports (with full opening available); floating ball for positive shut-off; adjustable Teflon stem packing; adjustable ball seal compression; generous stem bearing for end thrust and side thrust; adjustable ball stops; hollow cast balls (6″ and larger). Balls are hard chromium plated.

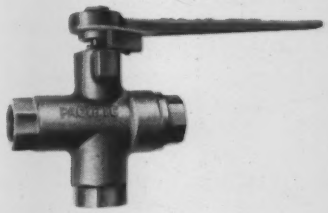


FIG. 20. PACIFIC offers 3-way ball valve.

Types available: Fig. No. 225 with screwed ends (¼″ to 2″, rated 125 psi steam, 225 psi to 1000 psi WOG, depending on body and seal materials); Fig. No. 400 with 150 psi ASA flanged ends (½″ to 2″, rated 125 psi steam, 175 to 275 WOG, depending on body and seal material); also made in sizes 2½″ to 14″ with adjustable Ball-Seal compression ring (with same ratings); three-way valves (Fig. 20) with screwed ends up to 2″; all-welded construction (for socket welding, Fig. No. 226 or with screwed ends for seal

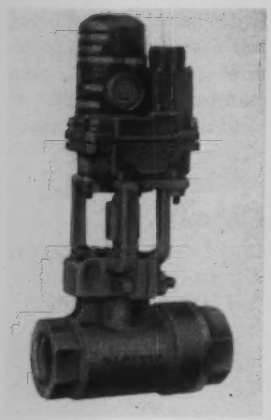


FIG. 21. ELECTRIC ACTUATOR on Pacific valve.

welding Fig. No. 225-X); self closing valve that shuts off when the handle is released, Models NSC and VSC; ratchet operated valves, Model NDO and VDO, (pull to open, then pull to close, etc.); and high-pressure type Fig. No. 225, rated up to 2500 psi with patented StēLok design ball seal of Teflon or Delrin.

Special stem packings are furnished for high and ultra-high vacuum service. Actuators are made as worm-gear, with or without chain wheel, or chain-lever types for overhead manual operation; and several pneumatic type operators are available. Electric motor actuators are available for 120 vac or 24 vdc (Fig. 21). All valves are available with "Fire-labeled" rating to provide fire-safe performance.

C_v ratings range from 2 for the ¼" size to 2000 for the 8" size.

Rockwell Mfg. Co.

Rockwell Hypresphere valves (Fig. 22) made in sizes 10" to 36", feature positive shut-off with "Sealdport" lubrication, fully protected valve seats, self-adjusting plug, full flow in either direction. The company classifies them as "lubricated spherical-plug valves."

They come equipped with 4-cylinder hydraulic actuators with 4-way control valve and hand pump, or, due to their seize, are operated by bevel worm gear, with automatic gas, electric, or line-pressure actuators plus manual auxiliary operation.

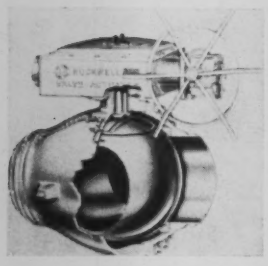


FIG. 22. ROCKWELL valve.

The valves are particularly suitable for those services where due to the nature of the fluid handled, line scraping may be desired. Such installations include sour gas, oil, and product lines.

Body material is electric-cast carbon steel. Sizes 20" through 30", have 400 psi ASA flanges with working pressure of 960 psi (Fig. No. 49), 1000 psi WOG rating (Fig. No. 109), or 1250-psi WOG rating (Fig. No. 129). Ends can be also flanged and butt welded, or butt welded. The 16" size comes also with 600-psi ASA flanges and working-pressure rating of 1440 psi WOG (Fig. No. 69).

Tube Turn Plastics

Tube Turn Plastic's top-entry thermoplastic ball valves (Fig. 23) are designed to enable performance of on-the-line maintenance almost instantly. One-man operation removes or installs the valve bonnet, one-piece ball-and-stem, and self-lubricating Teflon seat-

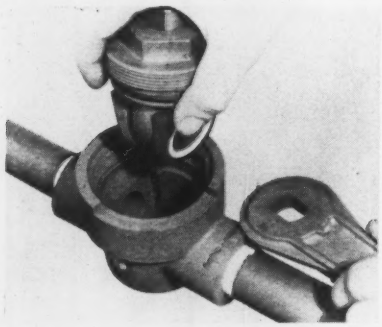


FIG. 23. TUBE TURN PLASTICS makes a valve serviceable without breaking line.

ing inserts. Valves are made of normal or high-impact unplasticized polyvinyl chloride (UPVC) or "Penton" chlorinated polyether in ½" through 3" nominal pipe sizes, threaded, socket, or flanged type. Adjusting nut on the valve bonnet permits adjustment of ball seating force from the top, eliminating need to break piping to perform this operation. All valves are manually operated.

Worcester Valve Co.

Worcester's Econ-o-miser valve line (Fig. 24) stresses versatility. Balls, stems, bodies, and pipe ends are available in many metals such as carbon steel, stainless steel, aluminum, and bronze.

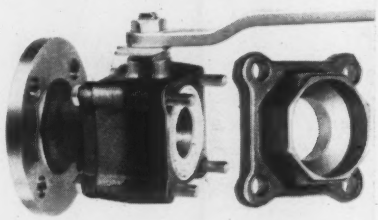


FIG. 24. WORCESTER valve has pipe ends bolted to body.

Standard valve sizes are ¼" through 2"; Series 400 has 150 psi ASA flanges. C_v ratings range from 8 for the ½" size to 1230 for the 6" valve.

There are 6 types of connections available—screwed, butt welded, welded-in nipple, flanged, socket-weld, and union cut-off. In certain cases different type connections have been used on both ends, also different materials.

Valves can be actuated remotely by solenoids, air cylinders, or other means. In one application Worcester valves are automatically actuated 90,000 ft above the earth to sample the atmosphere.

High-Power Valve Actuators

J. C. BOONSHAFT
Boonshaft and Fuchs Inc.

Combination electro-hydraulic and pneumatic-hydraulic techniques are used for high power and fast response.

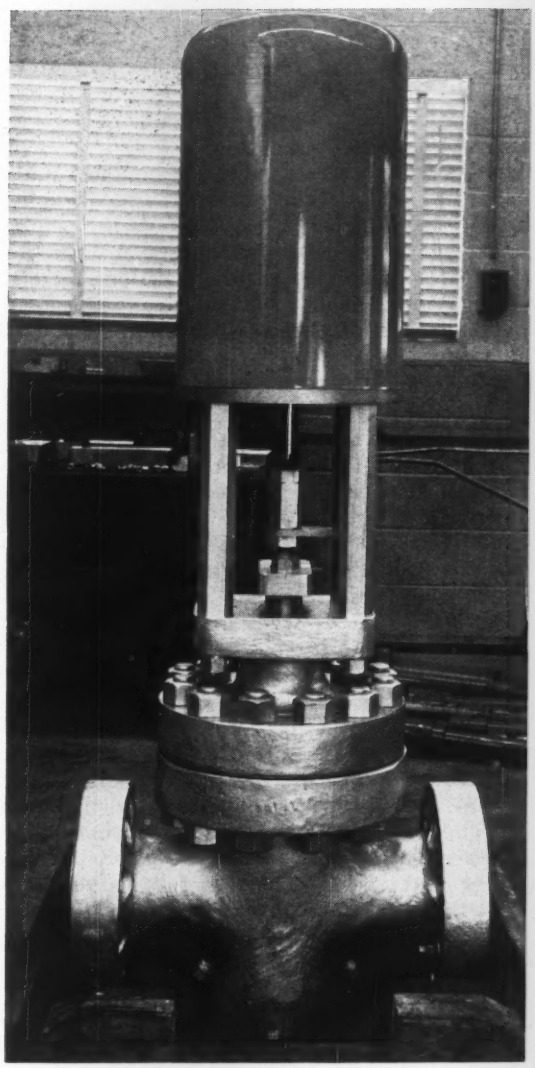


FIG. 1. TYPICAL electro-hydraulic valve actuator.

COMBINATION ACTUATORS fall in the field of high speed and high horsepower servo devices, and usually are to be considered when the horsepower requirement at the actuator exceeds one or two tenths of a horsepower (below which all-electric actuators usually are satisfactory). Pneumatic actuators are available to several horsepower, but have serious limitations in frequency response, stiffness, and resolution. These limitations can be overcome by the combination actuators described in this article. The horsepower limitation of these combination actuators is entirely cost rather than feasibility, and several units in excess of 500 horsepower to the control valve have been constructed.

Almost any reasonable combination of stroke length, stroke speed and stroke force is possible, particularly in the electro-hydraulic type where compensating networks frequently are employed to enable the valve. It is difficult to generalize, but most of the single-seated valve applications fall within the ¼-to-50-horsepower class, and butterfly valves fall within the 1-to-500-horsepower class. Full-stroke speeds in the range of 0.2 to 0.5 second are usual, and the typical actuator shown in Fig. 1 provides a stroking force of 40,000 lb.

The actuator may also be required to be (1) linear (for typical single-seated process valves), (2) rotary (with rotation being less than 360° for butterfly and ball valves), or (3) continuous rotary (used for an occasional special valve).

The bandwidth of these actuators in the usual application falls within the 2-to-20-cycle-per-second region. Higher bandwidths are possible.

Each type of actuator can be made either as an electro-hydraulic actuator (wherein the input command and position feedback signals are electric) or pneumatic-hydraulic (wherein the command and position feedback signals are pneumatic, generally 3-15 psi). The electro-hydraulic type is usually made both as an integral self-contained actuator with direct mechanical position feedback, and as an actuator which requires a servoamplifier in completing the position loop. A typical servoamplifier is shown in Fig. 2.

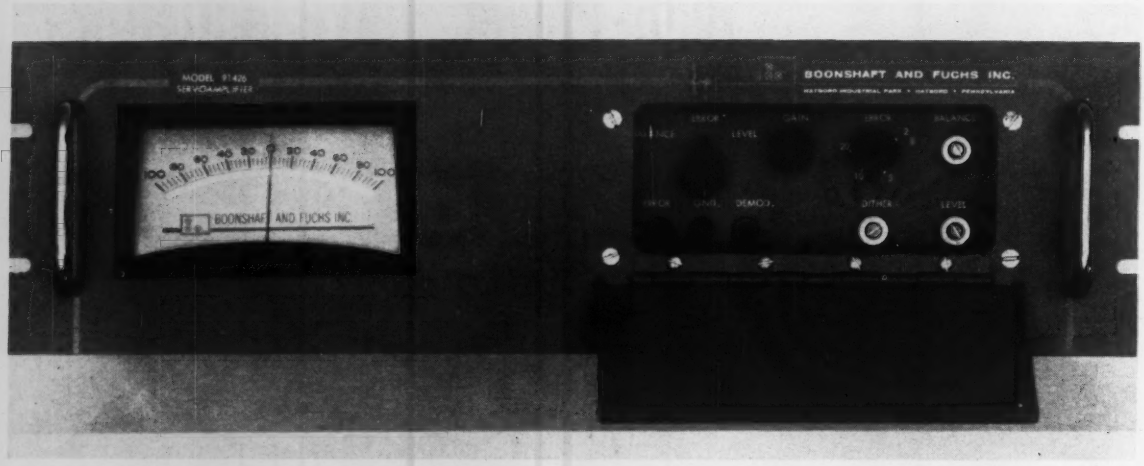


FIG. 2. EXTERNAL SERVOAMPLIFIER used with electro-hydraulic valve actuator.

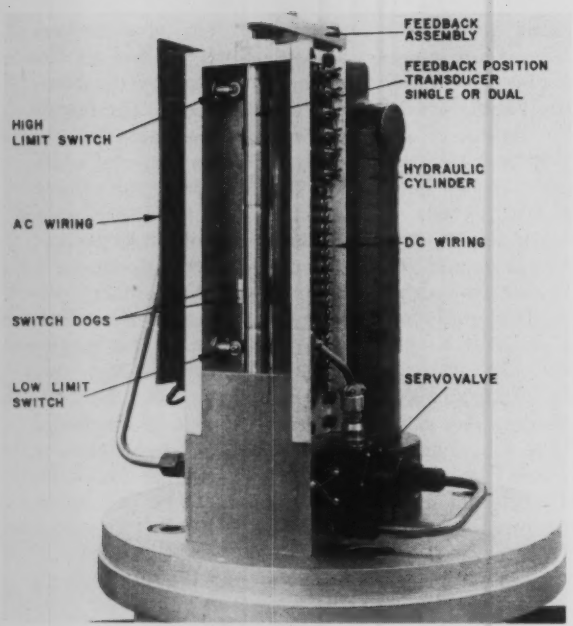


FIG. 3. MAIN ASSEMBLY of electro-hydraulic actuator used with external servoamplifier.

The choice of actuator, with or without servoamplifier, is a matter which concerns bandwidth, stroke linearity, and resolution. With servoamplifiers permitting a great deal of gain in the loop to be taken at the servoamplifier, stroke linearities of 0.2% are possible. Without servoamplifier, the best available is approximately 1%. Resolution of these units when operated with a servoamplifier may be as high as 1 part in 50,000 of full stroke, while without the servoamplifier 1 part in 1,000 is usual.

Other than horsepower capabilities and the high bandwidths possible in hydraulic actuators, there are two important reasons (seldom mentioned in the literature) for the use of this type of equipment. These are as follows:

1. **High resolution:** The resolution of the electro-hydraulic operator has been measured as high as 1 part in 50,000 and the poorest expected will be 1 part in 5,000 or better. This resolution allows a smoothness of operation that permits tight control loops of which other operators are not capable, and most important, this resolution in effect extends the rangeability of any control valve with which it is used by making extremely close positioning around the seat possible.

2. **Stiffness:** Stiffness is described best as the ability of the valve actuator to hold a command position independent of varying valve loads or, inversely, the change of command necessary in order to produce full thrust capability in the actuator. The usual electro-hydraulic actuator has a stiffness of 0.02% with a range as small as 0.005%. This means that a change in command of 0.02% of full-scale produces full thrust output capability of the actuator. The pneumatic-hydraulic actuator has a stiffness of approximately 0.2%—i.e., a change in command of 0.2% of full scale produces the full thrust capability of the actuator. This stiffness factor is important in several ways—(1) the ability of the actuator to move with the exceedingly small resolutions stated above, and (2) and perhaps the most importantly, the ability of the valve to hold a commanded position despite pressure upsets either up or downstream from the control valve.

Fig. 3 shows the main assembly of an electro-hy-

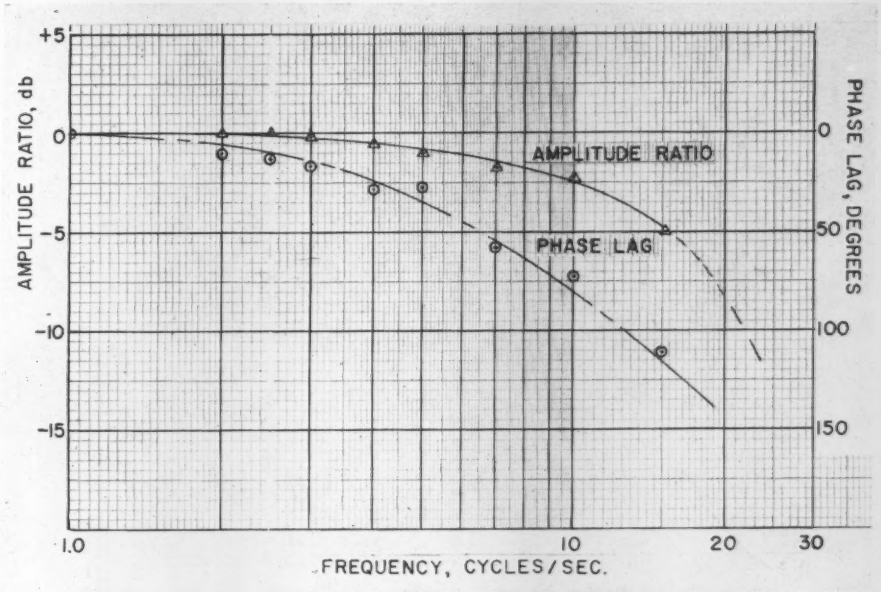


FIG. 4. FREQUENCY RESPONSE of pneumatic-hydraulic actuator.

draulic operator, the full view of which is shown in Fig. 1. The entire feedback assembly, together with position transducer, limit switches, servovalves, etc. is an integral assembly which permits quick exchange and/or repair. In these actuators, the feedback assembly is brought as a bridge across the cylinder; an arm is taken from both the top end and the lower end of the cylinder (double ended cylinders are always used) with a connecting arm between the two to hold a parallel assembly from which the connection is made to the feedback position transducer. This construction helps safeguard the feedback position transducer in the event of bending of the assembly. The low-level or d-c wiring is brought to one side of the assembly, and that associated with the limit switches to the other side of the assembly. This is important to prevent switch transients from upsetting control. The unit shown in this picture is an electro-hydraulic actuator for use with an external servoamplifier.

Fig. 5 shows the pneumatic-hydraulic type. In this actuator the error signal is formed as part of the pneumatic-hydraulic servovalve; no auxiliary control equipment is needed to operate it. This picture also illustrates a type of feedback which makes possible extremely long strokes as well as characterization. We have found that resolutions as high as 1 part in 1,000 are available by use of a machine taper (providing both sides of the taper are followed and the position signal is the result of the width of the taper at any point rather than its location in space).

The frequency response of the pneumatic-hydraulic actuator is shown in Fig. 4. The frequency response of the electro-hydraulic type may fall, by design, into a wide range of characteristics. Fig. 4 is not the best which has been achieved with the pneumatic-hydraulic type, but represents the state of the art today.

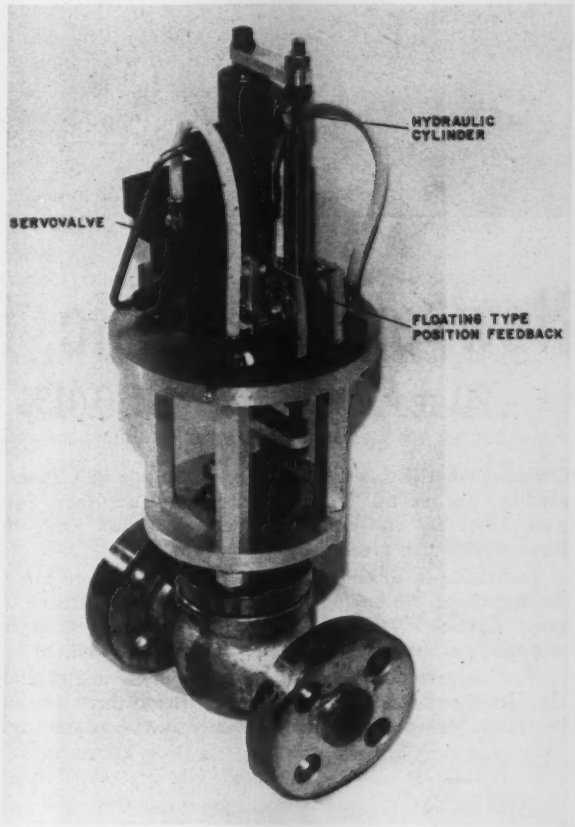
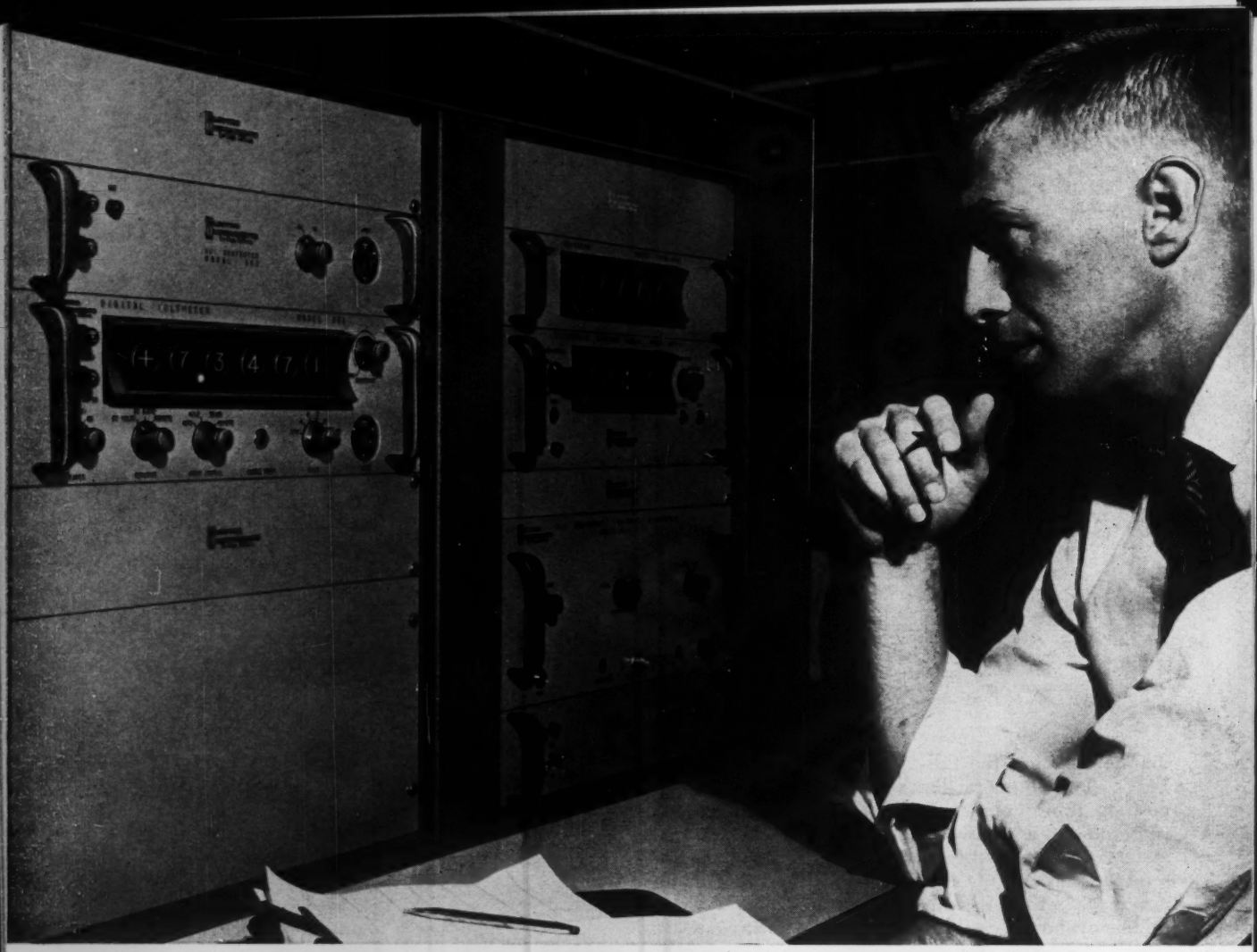


FIG. 5. PNEUMATIC-HYDRAULIC valve actuator with floating-type feedback assembly.



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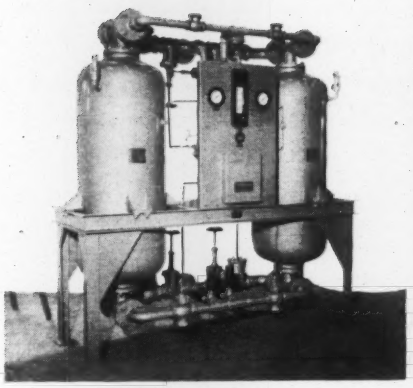

HEATLESS REACTIVATION OF DESICCANT DRYERS

Moisture can be removed from a desiccant-type dryer by air-drying the desiccant, rather than heating the desiccant. Dryness below any known means of measurement can be achieved.

MOISTURE-HOLDING CAPACITY of air is inversely proportional to its absolute pressure. The higher the pressure, the less water it can retain per standard cubic foot. The moisture-holding capacity of air also rises sharply with an increase in its temperature. With every 20°F rise in temperature, its water vapor capacity is approximately doubled.

SATURATION is the maximum amount of water vapor that air will hold at a given temperature and pressure.

DEWPOINT is the temperature at which the water vapor begins to deposit or condense as a liquid at a given pressure.

It is often difficult to understand how atmospheric air should become saturated when compressed. Assume atmospheric air at 80°F is 50% saturated; it will contain 5.72 grains of moisture per cubic foot (7000 grains equal one lb). If 1 cubic foot of this air is compressed to 103 psig (eight times the atmospheric pressure, or 7 x 14.7) it would have one-eighth of its former volume (or, it would take 8 cubic feet of air at atmospheric pressure to equal one cubic foot at 103 psig). By compressing 8 cubic feet of this air to 103 psig, 8 times 5.72 grains of moisture is in 1 cubic foot, or 45.8 grains, approximately 400% saturation. If it were not for the heat of compression (approximately 400°F) which tremendously increases the water-holding capacity of air, this excess moisture would immediately condense.

This hot, super-saturated air is then generally passed through a water-cooled heat exchanger. The cooling effect reduces the air temperature, causing the excess moisture to condense in the form of liquid water, which is then mechanically separated. However, this cooled air is still saturated at its reduced temperature, and any further reduction in temperature will cause additional condensation.

Some installations do not use an aftercooler, relying on the air to cool in the air receiver. This is not desirable for heavily-loaded air systems because the air will not remain in the receiver long enough to cool. Consequently, it will cool as it leaves the receiver, depositing condensed water in the air lines. This same condition will be observed in the event of a malfunctioning after cooler, separator or trap.

There are four major methods of removing water vapor from compressed air:

1. *Mechanically,* by lowering the temperature through cooling or refrigeration, or by increasing the pressure by compression. Unless high-pressure air is required elsewhere, economics seldom will justify the high cost of high-pressure equipment purely for dehumidification purposes. Cooling the air by refrigeration is a fairly common method of dehumidification, if low dewpoints are not required. In general, most refrigeration dehumidifiers can rarely produce dewpoints below +32°F at pressure because of icing problems on the cooling coils. It should be noted that air with a dewpoint of +32°F at 100 psig will have a dewpoint of only +5°F at 15 psig, or −10°F at atmospheric pressure. These dewpoints are not suitable for instruments or process equipment subjected to field temperatures below 5°F.

2. *Chemically,* through the use of reactive chemicals such as sulfuric acid, phosphorous pentoxide, etc. Generally, this type of drying is limited to laboratory-type applications because of the cor-

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rosive nature of the chemicals involved.

3. *Absorptive,* through the use of chemicals that dissolve or change in the presence of water. Calcium chloride and salt are forms of solid absorbent, and typical liquid absorptives include ethylene glycol, etc. This type of absorptive dehumidification is not capable of providing low dewpoints because the vapor pressure of the materials employed is not much lower than the vapor pressure of saturated air. Consequently, there is a minimum of dewpoint depression because the amount of water vapor transfer from the air to the absorbent is limited. In addition, many of the soluble salts commonly used have a corrosive precipitate requiring constant replenishment and care to see that overloads or line surges do not carry over corrosive vapors into the downstream line.

4. *Adsorption,* through the use of chemically inert desiccants such as Silica Gel, Activated Alumina, Molecular Sieves, etc. Adsorptive desiccants have few of the disadvantages of the previous methods and are capable of providing extremely low dewpoints. Commercial desiccant dryers are now available to produce dewpoints below −100°F at line pressure.

The water adsorption capacity of any desiccant is expressed in the pounds of water it can adsorb per pound of desiccant until the dewpoint curve rises sharply. In theory, most desiccants can adsorb up to 20% of their weight in water before this breakpoint is reached. In actual practice, however, most desiccant dryers are designed to adsorb 12 to 15% of their desiccant weight before the chamber is switched over to the regeneration cycle. By careful design, adequate purge rates, and proper regeneration temperatures, a consistent effluent dewpoint can be obtained together with long desiccant life. Excessive water loads or oil saturation, low purge rates, insufficient or excessive regeneration temperatures will reduce the desiccant adsorptive capacity and hinder proper operation.

Reactivating the Desiccant

In a conventional heat-reactivated desiccant dryer, air or gas flows through the desiccant chamber until the water vapor adsorbed by the desiccant reaches equilibrium with the water vapor in the air stream. At that time the flow of air or gas is switched to a second chamber of the desiccant dryer; the first chamber then is reactivated—that is, it is heated to drive off the water vapor. After reactivation the desiccant is cooled and the chamber again is ready to adsorb water vapor from the air or gas stream. Note that *temperature* controls the reactivation of the desiccant.

In heatless reactivation, on the other hand, the *pressure* of the air or gas over the desiccant is changed so that the desiccant gives up its water to the purge air.

The principle used is the simple one that relates the pressure of a gas and the vapor pressure of its entrained water. If the pressure of a gas is halved, its water vapor pressure also is halved, assuming isothermal conditions. If 60-psig air has

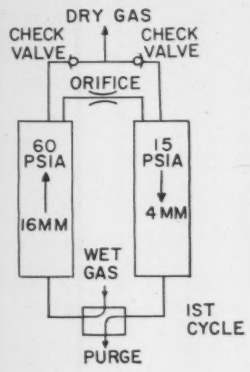


FIG. 1. DURING FIRST cycle of operation, wet air is at 60 psia and has water vapor at a pressure of 16-mm Hg; reducing this pressure to 15 psia causes the water vapor pressure to be reduced to 4-mm Hg.

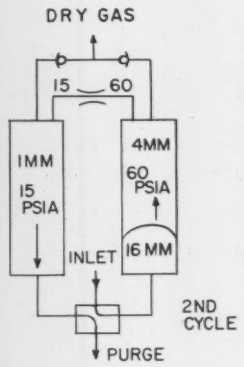


FIG. 2. DURING 2ND cycle, the 60-psia air is dried to a water vapor pressure of 4-mm Hg, and reducing the pressure reduces the water vapor pressure to 1-mm Hg in the reactivating tank.

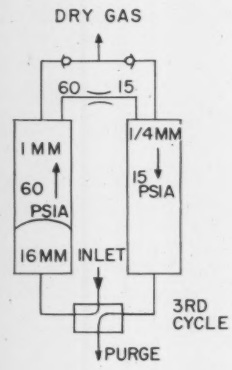


FIG. 3. DURING 3RD cycle the 60 psia air is dried to 1-mm Hg vapor pressure, and the 15-psia tank has a vapor pressure of 1/4-mm Hg.

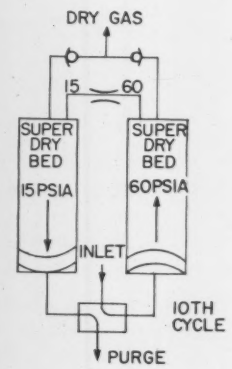


FIG. 4. AFTER repeated cycles both beds are super dry.

a water-vapor pressure of 16-mm Hg and if its pressure is reduced to 15 psia, then the vapor pressure of its entrained water will be reduced to 4-mm Hg.

By successive changes in pressure, a desiccant in contact with air having a water vapor pressure of 16-mm Hg can be dried as follows:

60 psia, 16 mm Hg → 15 psia, 4 mm Hg.

60 psia, 4 mm Hg → 15 psia, 1 mm Hg.

60 psia, 1 mm Hg → 15 psia, ¼ mm Hg.

60 psia ¼ mm Hg → 15 psia, 1/-6 mm Hg, etc.

Let us consider air at 60 psia, with a water-vapor pressure of 16-mm Hg, flowing at a constant rate through a chamber of desiccant (Fig. 1). The vapor pressure of the water held by the desiccant will increase until it comes to equilibrium with the vapor pressure of the water in the air flowing over it (16 mm Hg). However, when the 60-psia air is reduced in pressure to 15 psia, the partial pressure of the water in the air drops to 4-mm Hg. Now the vapor pressure of the water in the desiccant in the right-hand unit will reach equilibrium with the water vapor in the air (4-mm Hg). After two minutes, let us say, all the desiccant in the right-hand unit has desorbed water to reach equilibrium at a vapor pressure of 4-mm Hg.

After two minutes the flow is reversed (Fig. 2); now the right-hand chamber receives the wet air at 60 psia with a water vapor pressure of 16-mm Hg. The desiccant adsorbs water until the water vapor pressure of the air is 4-mm Hg. This forces the 4-mm front toward the effluent end of the chamber. A portion of the emerging air goes through the orifice into the left-hand chamber, which is now at 15 psia. The purge water vapor pressure now is reduced to 1-mm Hg.

In the third cycle the left-hand chamber dries the 60-psia air to 1-mm Hg. The right-hand 15-psia chamber now has a water vapor pressure which is reduced to ¼-mm Hg. This relationship continues each time the flow of air or gas is switched from one chamber to the other. Note that the greater the ratio between line pressure and purge pressure, the quicker a low-dewpoint effluent is obtained.

This sequence soon obtains a degree of dryness far below that which is obtainable with heat-reactivated dryers. *The ultimate dryness that is obtainable with this process is beyond any present known means of measurement with commercially-available dewpoint equipment.* Standard equipment operating in the field has had the effluent air exposed in several cases to a temperature of −200°F, without any sign of moisture in the effluent stream.

Oil Carryover

Oil carryover from a compressor can cause serious problems in many applications. Liquid oil can be effectively removed by mechanical separators or scrubbers, and oil vapors by desiccant-type prefilters employing activated alumina, etc. Until recently it has been thought that most of the oil deposited in downstream piping or equipment was caused by oil vapors which were not trapped out. It has been established recently that in many installations these oil deposits are caused by oil mist or fog in aerosol form. This mist, which is believed to consist of a film of oil surrounding a bubble of air, cannot be trapped out or adsorbed by desiccants. To date, no effective means has been found to remove or coalesce this mist, although intensive research programs may soon solve this difficult problem.

If the process must be free of oil contamination, the only positive way to provide oil-free air is to utilize a non-lubricated compressor. Recent developments in the use of Teflon rings in non-lubricated compressors have greatly increased their reliability and service life.

Drying Economics

The operating efficiency of the heatless versus heat-reactivated method can be found by calculating the cost of the purge air as compared to power or steam requirements. However, there are other advantages with this new process which must be considered to obtain a true total cost of dry instrument air.

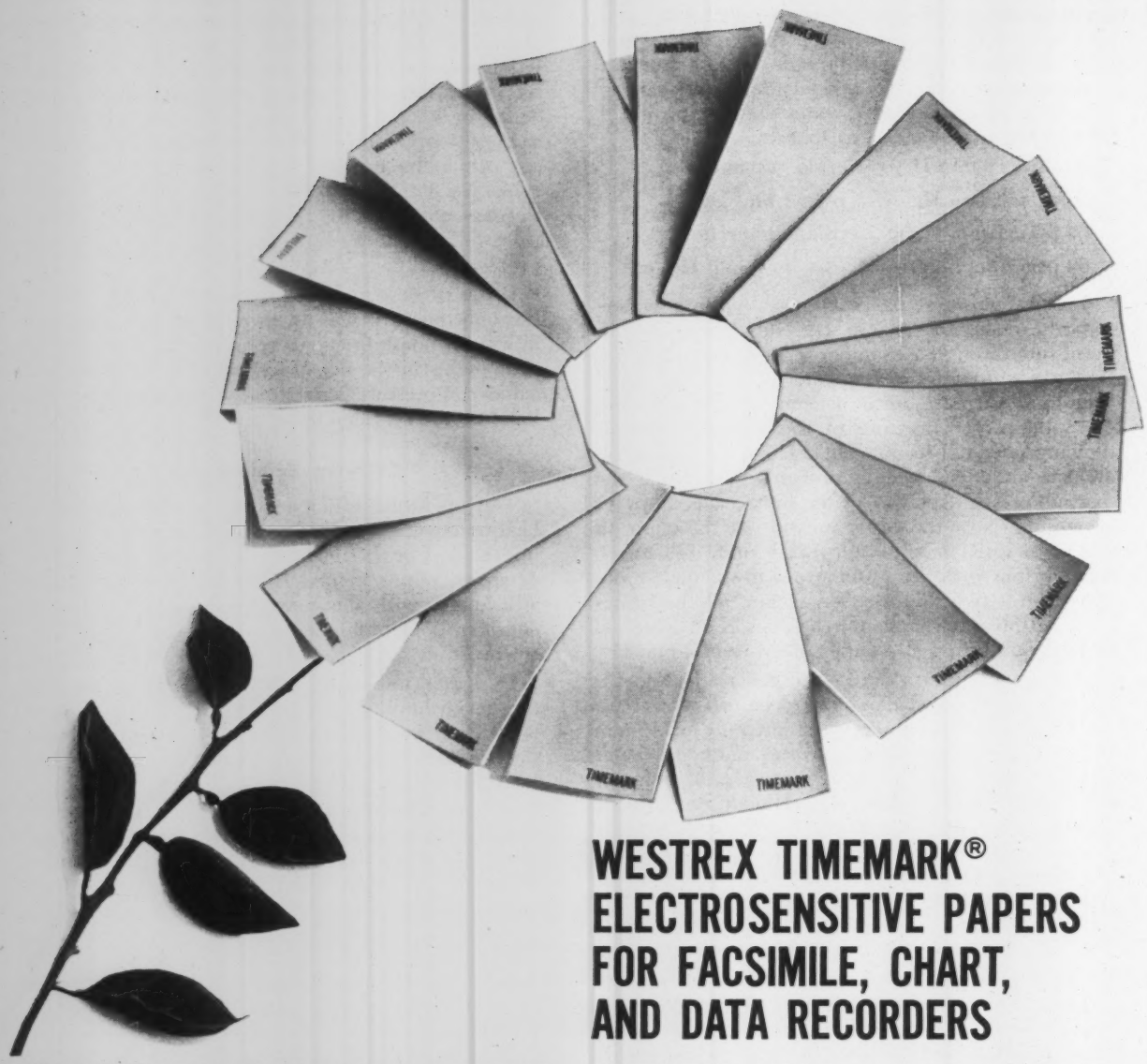
Of major importance to the instrument man is the basic simplicity of the dryer itself. Equipment is reduced to simple valving and desiccant chambers, eliminating many components required on heat-reactivated equipment.

Air temperature fluctuations do not affect dryer size if the heatless method of reactivation is used. It is a good rule of thumb to say that the amount of water present in compressed air doubles with every increase of 20 F°, provided the pressure remains constant. Therefore a heat-reactivated dryer must have twice as much desiccant to dry a given flow of air at 100°F than if the air is at 80°F. However, the heatless method does not require additional desiccant, and the same dryer size is applicable at 80°F, 100°F, or 120°F. A militarized design using heatless reactivation was tested under Navy MIL-T5522, and provided dewpoints under −100°F while drying air at temperatures ranging from −65°F to +140°F.

Many instrument air systems have corrosive compounds present due to the nature of the plant or its location. When exposed to the temperature required for heat-reactivated dryers, these compounds may form corrosive condensates, which create maintenance problems. This is not the case when the heatless principle of reactivation is used.

Hydrocarbon vapors also hamper heat-reactivated dryers as the vapor is carbonized by the heat, thereby clogging the pores of the desiccant. Heatless reactivation rejects this vapor, and should an oil aerosol pass through the heatless dryer, it will still provide low dewpoints.

The above features, added to low initial cost, make this method of desiccant drying compare favorably to the heat-reactivated method in at least 80% of instrument air installations.



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HYDRAULIC VALVE ACTUATORS SAVE HALF-MILLION DOLLARS

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The Fluor Corporation, Ltd.

One third of the $1.5-million cost for instrumentation for a butadiene plant was saved by using hydraulic actuation of large (3″ to 30″) gate valves. Reactor is controlled by time control of a sequence of operations. Actuator power is up to 25 hp.

APPROXIMATELY one-half million dollars were saved recently in the design of the reactor control system of a butadiene plant. This represents one-third of the total instrumentation cost for the plant. The significant saving was achieved by providing *hydraulic power* rather than *electric power* to control the sequential operation of large gate valves which switch fixed-bed catalytic reactors from the reaction cycle to the regeneration cycle.

In the past, valve operation usually has been by direct-connected electric motors. Since each valve required its own individually mounted electric motor, the total installed horsepower required was approximately twenty times the average horsepower. In the search for a more flexible and economical control system, hydraulic power was investigated. This simplified operation of the system because only one small (30-horsepower) electric motor was required at a central power unit, and the valves were operated by small hydraulic cylinders.

This was the first application of a hydraulic system to such a process and is one of the largest industrial applications of hydraulic power for a continuous operating control system.

The hydraulic system, designed and installed by The Fluor Corporation, Ltd., is in operation at the Texas Butadiene and Chemical Corporation at Houston, Texas. A similar installation, by Fluor, is in operation at the Odessa Butadiene Company in Odessa, Texas, and represents a proportional saving. This basic design has been followed by others; there are now four butadiene plants in operation with hydraulic control of the reactors.

Wed., Nov. 15, 1961—Rio Hondo Country Club, 10627 South Old River Rd., Downey, Calif.
Subject: "An Engineer Looks Behind the Iron Curtain."
Speaker: Mr. Harry E. Burke, Vice President, General Manager, Consolidated Systems Corporation (ISA's representative in Hungary at Budapest MIKO Conference and Moscow Conference).

System Description

The installation at Texas Butadiene and Chemical Corporation has two parallel dehydrogenation units which catalytically convert n-butane to butadiene and butylenes (Fig. 1). Each unit consists of seven fixed-bed catalytic reactors with its own central hydraulic control system. The installation at Odessa Butadiene Company is identical to the two Texas Butadiene and

*Formerly of The Fluor Corporation, Ltd.

Presented at Texas A. & M. Fourteenth Annual Symposium on Instrumentation for the Process Industries, conducted by the Department of Chemical Engineering of the Agricultural and Mechanical College of Texas College Station, Texas.

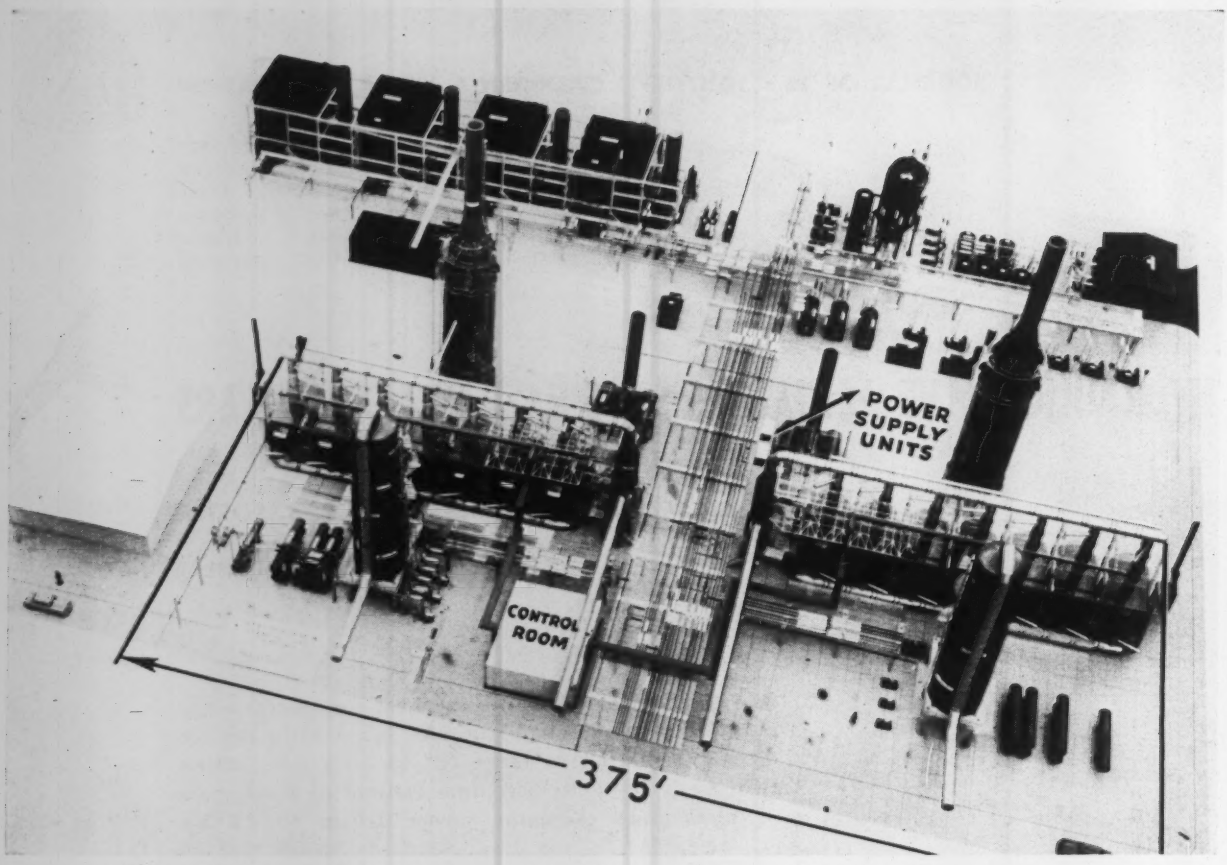

FIG. 1. TWO PARALLEL dehydrogenation units operated by central hydraulic control systems.

Chemical Corporation Units except that it has eight reactors. This discussion of the hydraulic system components is limited to one of the two units at Texas Butadiene and Chemical Corporation.

The process operates on a sequential cycle which consists of onstream steam purge, catalyst regeneration, gas purge and evacuation time intervals. This sequence is controlled by a 900-point master electric cycle timer (Fig. 2) which has a twenty-one minute cycle. The timer initiates signals to four-way solenoid-operated valves, which direct hydraulic oil from the central hydraulic system to either the opening or closing side of hydraulic piston operators mounted on the gate valves. Each reactor has seven of these gate valves ranging from 3″ to 30″ in size, making a total of forty-nine valves (ninety-eight for both units.) Fig. 3 shows a closeup of a few reactors and gate valves.

Each valve must fully stroke in five seconds, but opens and closes only once every twenty-one minutes. The maximum instantaneous power requirement is approximately 25 horsepower. In the all-electric system, an individual electric motor operator is mounted on each valve, adding up to some 500 horsepower available, but most of which is idle at any instant. In the hydraulic system, with the aid of hydraulic accumulators to provide additional capacity when it is needed, only 30 horsepower is required.

For complete safety of operation, an independent test circuit and interlock system prevents any valve from stroking unless all other valves on that reactor are in the predetermined safe operating position for that particular phase of the process cycle.

Power Unit

The hydraulic power supply unit (Fig. 4) is a continuous circulating system that provides the power necessary to operate the gate valves when signalled from the cycle timer. The process cycle inherently causes intermittent high and low demands for hydraulic capacity since at some times two 30″ valves must operate simultaneously; at other times only one 3″ valve must operate. It is recognized that a 30″ valve operator demands considerably more oil flow than a 3″ valve operator. Hydraulic accumulators pressurized with nitrogen are provided to give the extra hydraulic capacity required for peak demand periods. This permits the use of smaller hydraulic pumps. During peak demands the pumps recharge the accumulators.

The hydraulic power unit shown in Fig. 4 consists of a 200-gallon nominal capacity reservoir, two normally operating 16.5-gpm 15-horsepower electric-motor-driven vane-type pumps operating at 1,000-psig discharge pressure, all packaged as a single unit. The system also includes ten 10-gallon hydraulic accumulators, and the required pressure control valves, flow control valves, manual valves and solenoid operated

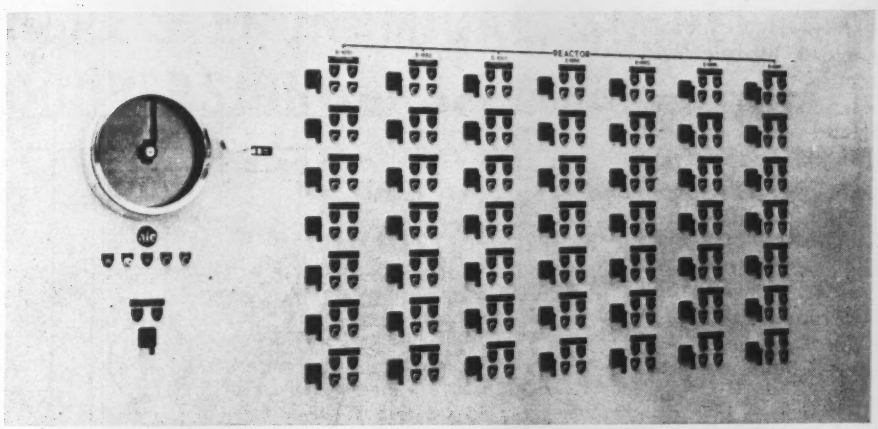

FIG. 2. CYCLE TIMER
control panel.

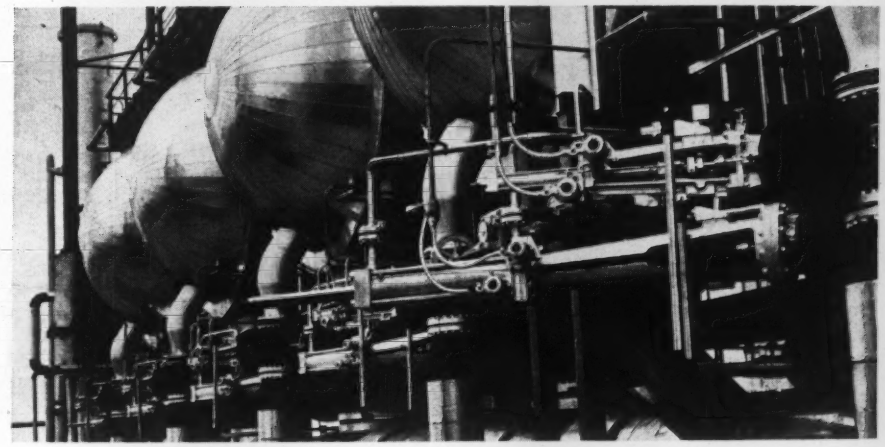

FIG. 3. REACTORS
and gate valves.

valves all integrally mounted on a hydraulic operating panel.

The most important rule in a hydraulic system is to "keep it clean." Dirt is the cause of 90% of hydraulic component failures. Therefore, a suction filter is supplied on each pump. An individual filter is supplied in the line to each gate valve, and parallel filters are used on the return oil line. These filters are arranged so that each may be blocked out of service and cleaned without shutting down the unit. The entire hydraulic system is designed for one year of continuous operation.

Operating Procedure

Fig. 4 shows a typical schematic arrangement of the hydraulic system components. The following operating procedure to open a reactor product outlet valve is typical for all valves: A rotating sweep arm on the cycle timer momentarily closes an electric contact to energize the "open" solenoid of the four-way valve. The four-way valve directs hydraulic oil to the opening side of the piston operator on the product outlet valve. When the valve piston begins to move, oil on the opposite side of the piston is forced through the return line back to the reservoir.

A pressure-compensated flow-control valve located in the oil return line controls the valve opening and closing speeds. This can be adjusted to meet the allotted time for each valve movement as dictated by the cycle timer. The flow controller for a 30" valve can control stroking times between four or five seconds and several minutes.

This timing is critical. If a valve does not stroke in its allotted time, the interlock system stops the cycle timer. If a valve strokes considerably faster than the allotted time, wear on the moving parts is increased.

In order to avoid "seat jamming" a valve, a pressure-reducing valve controls the oil supply to the closing side of the piston operator at a lower pressure than the supply to the opening side.

A four-way bypass valve is provided to manually operate each gate valve in event of failure of the solenoid-operated four-way valve.

As indicated in Fig. 4, the gate-valve cylinder has a hydraulic cushion on each end of the cylinder to slow up or brake the valve movement during the last portion of its travel. This is an additional safety feature to prevent slamming of the valve.

The hydraulic circuit equipment, consisting of the four-way valves, filters, flow controllers, pressure controllers, manual bypass valves and accumulators, was prefabricated on individual panels. These were later mounted on the reactor structure forty feet above grade.

Hydraulic Fluid

The hydraulic fluid used in the system serves both as a power medium and lubrication for moving parts.

One of the most critical items in the design of a system of this type is to provide a clean, air-free fluid with the right viscosity characteristics.

The hydraulic fluid must be chosen carefully. For outdoor installations, the summer and winter ambient temperatures must be investigated before specifying the viscosity of the fluid. The viscosity must not change greatly from winter to summer temperature extremes. If this temperature difference is large, provision must be made for cooling the return fluid in the summer and heating it in the winter. Consideration must be given to the narrow viscosity ranges for which pumps and other components are designed.

The hydraulic hardware (flow-control valves, pressure control valves, and four-way valves) is designed so that to operate properly it must continually bleed or leak a small amount of hydraulic fluid from the valve pilots to the reservoir. This amount of leakage must be taken into consideration when calculating the pump capacity. If the hydraulic fluid viscosity is too low, excessive pilot leakage develops, possibly resulting in insufficient pumping capacity. If the viscosity is too high, the system becomes sluggish and excessive pressure drops occur, which can slow up stroking times enough to shut down the process unit.

If the hydraulic fluid is not heated, it should have a pour point 20° or 30°F below the lowest expected winter temperature. It should include rust and oxidizing inhibitors, anti-foam inhibitors and should have good lubricating characteristics. Recent developments have been made in synthetic lubricants and fire-resistant hydraulic fluids which should be considered where fire-resistance is a design factor. However, these "hydrolube" type fluids are expensive. Since approximately 2,000 gallons of hydraulic fluid is required to fill and operate the system, the cost of the fluid is an important consideration. The highest quality fluid will usually pay dividends in less maintenance and improved performance.

Operating and Maintenance Problems

Twenty-eight of the forty-nine gate valves are located above the reactors and the remaining twenty-one are at grade sixty feet below. It was necessary to chemically clean and flush out the several miles of hydraulic piping before filling the system with oil. A high velocity of flushing is recommended to completely clean out all bends and low spots where dirt is likely to lodge.

During start-up, extreme care must be taken to vent all air from the system to avoid erratic operation, such as valve slamming and irregular stroking times.

Despite all precautions, it is difficult to keep dirt and scale out of the piping system during the construction stages. This foreign material must be flushed out and, therefore, drain connections must be located at the low points.

In addition, every valve cylinder operator should be mounted so that it can be vented and drained at its respective high and low points. Otherwise anything trapped in a cylinder is likely to remain there.

Due to the long piping runs to the reactor valves located at grade, the fluid in these lines is never displaced enough to carry it out into the return system

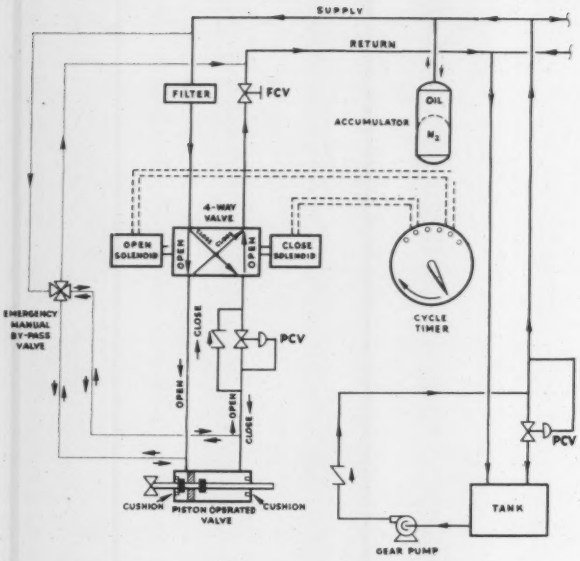

FIG. 4. HYDRAULIC operating system.

and back to the reservoir; therefore, in colder climates, these lines must be heated by some means to keep fluid viscosity at the optimum value.

A drip pan or gutter at the bottom of each hydraulic panel is a convenience because every time a component is removed for cleaning or servicing, some fluid runs out of the piping.

Hydraulic piping must be supported adequately to minimize line vibration caused by hydraulic shock resulting from sudden shifting of the gate valves.

Conclusions and Recommendations

Applications of a hydraulic system for a sequential cycling process, where the average hydraulic fluid flow is low and peak demands are high, can represent a substantial initial cost-saving over an all-electrical system. The maintenance costs are much less for the hydraulic systems now in operation than for an all-electric system. Routine maintenance costs are approximately one-quarter of those for an electric system. Down-time maintenance costs are approximately one-half those of an electric system.

The hydraulic-fluid specifications must be chosen with climatic conditions in mind. Inherent hydraulic equipment leakage requirements must be considered when determining the pumping capacity. Caution must be taken to keep the system clean during installation and operation. Locations for venting and draining of the system must be chosen wisely. Pump capacity, valve capacity and leakages, and pressure drops should be tested as nearly as possible under actual operating conditions at the manufacturer's shop. These precautions will result in an economical and dependable hydraulic control system.

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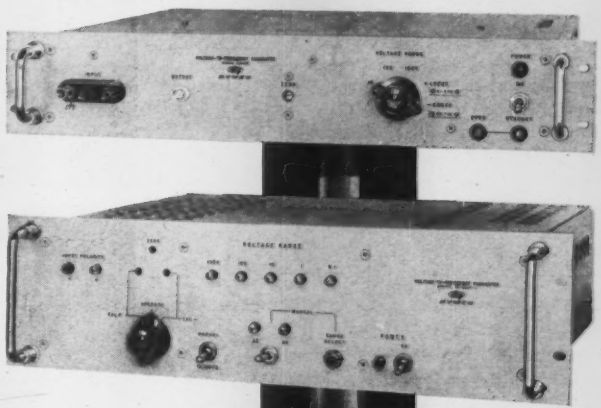

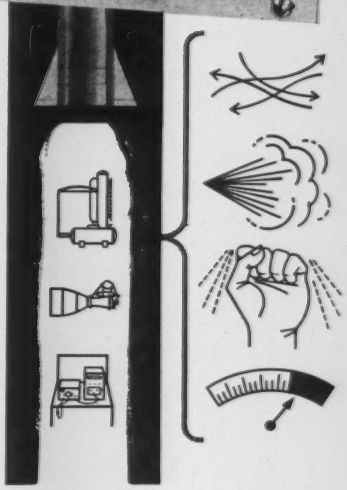

Dymec Models 2210 and 2211A/B Voltage-to-Frequency Converters average out noise and hum to obtain high-accuracy voltage measurement. This is especially advantageous in systems applications. You get higher useful measurement accuracies than with other conversion techniques.

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	Dymec 2210/2210R	Dymec 2211AR/BR	Dymec 5207-1
Ranges: (VDC, ±, full scale)	±1 ±.1 ±10 ±1 ±100 ±10 ±1000 ±100 } *	* { ±1 ±.1* ±10 ±1 ±100 ±10 ±1000 ±100 } *	DC { ±.1 1 ±1 10 ±10 100 ±100 750 ±1000 } AC volts, rms, 20 to 100,000 cps
Output Frequency:	0-10 KC	2211AR, 0-10 KC 2211BR, 0-100 KC	0-10 KC
Accuracy:**	±0.06%	2211AR, ±0.02% 2211BR, ±0.03%	±0.06% dc ±0.5%, 50-10,000 cps ±0.75%, 20-100,000 cps
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Price:	DY 2210, $660.00 (cabinet) DY 2210R, $650.00 (rack)	$1,250.00 (rack)	$1,850.00 (rack)

*Available at extra cost. **Accuracy includes stability, is given in per cent of full scale and is affected by frequency and accuracy of calibration, line voltage variations, temperature changes and accuracy of multi-range input attenuators. Figures given are those attained under normal operating conditions. ***Given as per cent of full scale per 24-hour day.

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CIRCLE 76 ON READER-SERVICE CARD

T. STICKNEY

A. ANDERSON

Mr. Anderson and Mr. Stickney have crossed paths often during their professional years. Mr. Anderson began employment as a physicist at the Naval Ordnance Test Station, China Lake, California, a few years after Mr. Stickney started his career as an instrumentation engineer at the NACA, now NASA, in Cleveland, Ohio, in 1948. Mr. Anderson joined NACA, Cleveland, in 1954. Both left government service for private industry in 1956—Mr. Anderson to Cook Research Laboratory and Mr. Stickney to Aero Research Instrument Company in Chicago. Mr. Anderson joined the latter company in 1958. Since June 1960, both men have been serving as senior engineers at Cook Research Laboratories, Morton Grove, Illinois.

Ceramic Resistance Thermometers as Temperature Sensors Above 2200°R

A. R. ANDERSON and T. M. STICKNEY

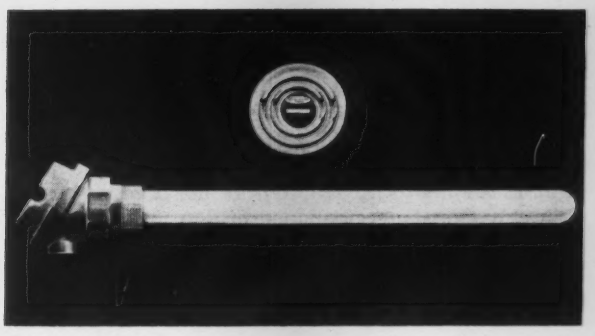
Cook Research Laboratories
Cook Electric Company

Although vitrified metallic oxide ceramics (zirconia, alumina, magnesia, and beryllia) are electrical insulators, the resistance between two points within the insulator decreases with increasing temperature. This decrease of resistance with temperature is similar to that of the conventional thermistor.

The application of vitrified ceramics as thermistor type sensor in the measurement of high temperature has been a subject of interest to investigators for approximately 40 years.[1, 2, 3] In 1960, the Cook Research Laboratories of the Cook Electric Company began independent research on the use of ceramic materials as temperature sensing elements at high temperatures in oxidizing atmospheres. This research has been fruitful.

Recently published texts and technical articles in the field of solid-state physics[4, 5] introduce Fermi-Dirac statistics to show the probable density of charge carriers in solids as a function of temperature. The conductivity, or resistivity, of a metallic conductor also depends on the mobility of its charge car-

Abstracted from a paper presented at Fourth Symposium on Temperature—Its Measurement and Control in Science and Industry—Columbus, Ohio, March, 1961.



PYRISTOR® ceramic resistance temperature sensor.

Vitrified ceramic oxides can be used as resistance thermometers above 2200°R. Aluminas of various purity have been investigated, as were zirconia, magnesia, and beryllia. Calibration of 60% alumina at temperatures from 2200 to 3300°R has shown a repeatable resistance-temperature characteristic which has not varied by more than ±0.57% from the mean curve after repeated calibrations covering a period of time exceeding 1000 hours. Similar results were found with 99% alumina. It is proposed that vitrified ceramic resistance elements be considered as temperature sensors for use above 2200°R.

riers. Ceramic insulators at high temperatures, however, closely approach the characteristics of intrinsic semiconductors for which mobility effects are minor. Theory predicts that for an intrinsic semiconductor, the logarithm of the resistivity *versus* the reciprocal of absolute temperature yields a straight line, showing resistivity decreasing with increasing temperature. Absolute temperature units used herein are degrees Rankine (°F + 460).

Experimental Apparatus

The experimental work was conducted in a furnace (Fig. 1). The heating element is a silicon carbide tube with the test probe shown installed within the tube. Temperatures were measured independently with both an optical pyrometer (as shown) and a reference-grade platinum-10% rhodium/platinum thermocouple installed within the test probe. The preponderance of data showed agreement between pyrometer and thermocouple within 0.50%.

Temperature gradients along the furnace length were measured and are shown in the lower portion of Fig. 1. The temperature profile within the center 12″ of the furnace length was flat within 0.50% of center element temperature, the ends of the furnace tube exhibiting the typical temperature decay for furnaces of this type. The test probe was inserted in the furnace such that the sensor (within the probe) was at the center of this flat profile, the sensor tube itself being subjected to this flat profile for a length of 19 diameters in the direction of the cold end of the probe.

Fig. 2 shows the internal details of the temperature probe, including the ceramic protection tube enclosing the active sensor and the thermocouple housing. One lead wire is carried through the internal bore of the sensor tube to the cold end of the probe. The other lead wire is brought from the sensor, across an end support piece to another ceramic tube, and is returned through the internal bore of the second tube.

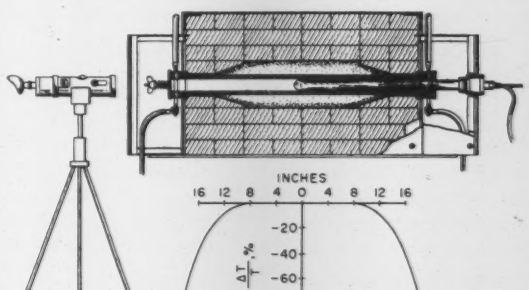


FIG. 1. GLOBAR element furnace.

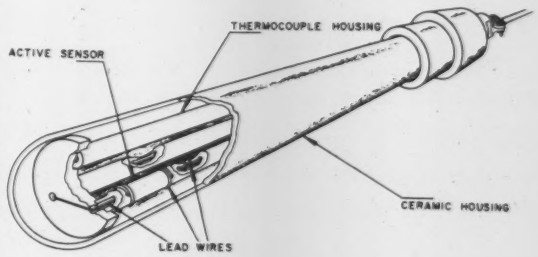


FIG. 2. SENSOR internal details. (Patent applied for.)

The ceramic oxides investigated as sensors were primarily aluminas of varying percentages of purity. Zirconia, magnesia and beryllia, tested on a limited basis to obtain a better understanding of their electrical characteristics, will be investigated further.

Two readout circuits were used in the testing of the ceramic sensors (Fig. 3). Much of the data was taken with a 1000-cps ac impedance bridge (Electro Scientific Industries, Model 250 DA) in circuit A. Data were also taken with a bridge and rectifier circuit (designed in our laboratories), the output of which was fed into either an oscillograph (Consolidated Electrodynamic Type S-119) or a null-balance potentiometer (Leeds and Northrup Cat. 8686), as shown in circuit B. This latter circuitry also was used to investigate the effect of a varying input alternating-current frequency.

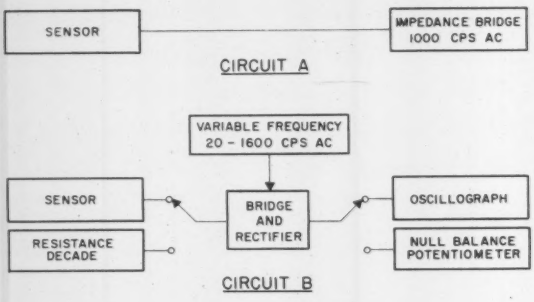


FIG. 3. CIRCUITRY.

Problem Areas

A major problem has been that of *lead attachment*. There are basically three methods which can be employed to attach leads to ceramic oxides. From available literature, it was found that much work has been done using pastes or cements[2, 3, 6]. Another bonding method is that of the semiconductor industry, using such techniques as moly-manganese or electro-less processes.

A third method is that of mechanically tying the leads to the ceramic. In the past this method relied partly upon cements to hold the leads in place and thus were subject to the problems of the first method discussed. A way to negate this is to drill holes transversely to the axis of the sensor and perform a mechanical loop-and-tie arrangement to secure the wire to the sensor. This method was successfully employed in our probe (Fig. 2).

AC or DC?

Another problem area is the use of alternating or direct current. This has been the subject of much previous investigation[2, 3, 6, 7]. The generally-accepted conclusion is that the use of direct current causes polarization of the ceramic. Consequently, the measured resistance increases with time of applied voltage, even if the current flowing is of the order of a few microamperes.

If alternating current is used, the effects of capacitance must be considered. This introduces another problem area—the effects of frequency on resistance of the ceramic.[7] Experiments were conducted at several frequencies from 20 to 1600 cps, at three temperatures. These data are shown in Fig. 4.

Resistance readings at 1000 cps are assumed to be the base resistances for comparative purposes. It is seen that the resistance is approximately 0.75% higher at 400 cps than at 1000 cps, whereas at 60 cps the resistance is approximately 5% higher. There appears to be no significant effect of temperature in the range investigated.

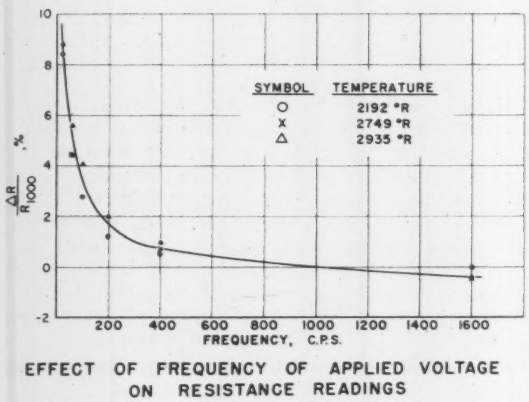


FIG. 4. EFFECT of frequency of applied voltage on resistance readings.

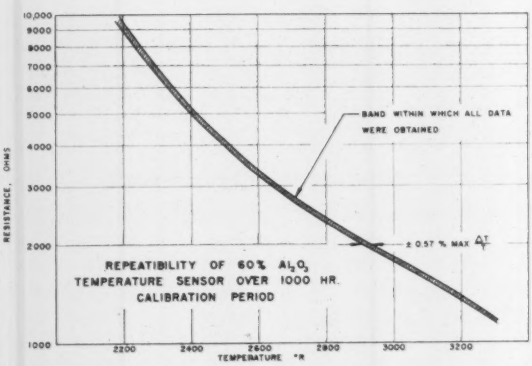


FIG. 5. REPEATABILITY of 60% Al_2O_3 sensor over 1000-hour period.

Shunting Effect of Air

Another problem area which weighed heavily in the design of the test probe is that of the electrical con-

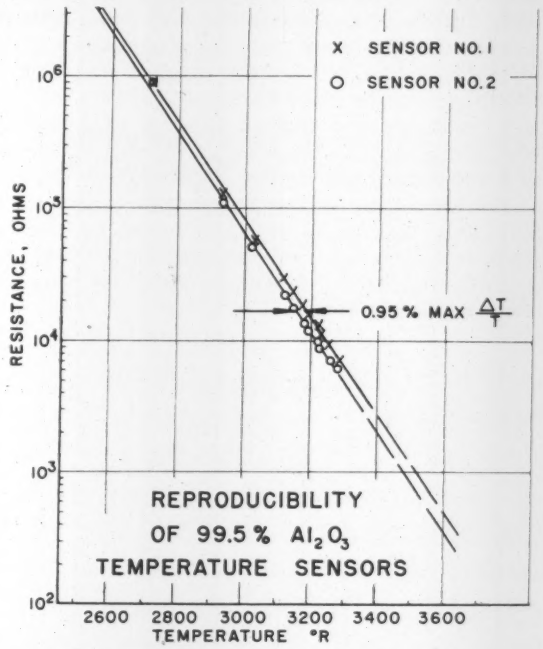


FIG. 6. **REPRODUCIBILITY** of 99.5% Al_2O_3 temperature sensors.

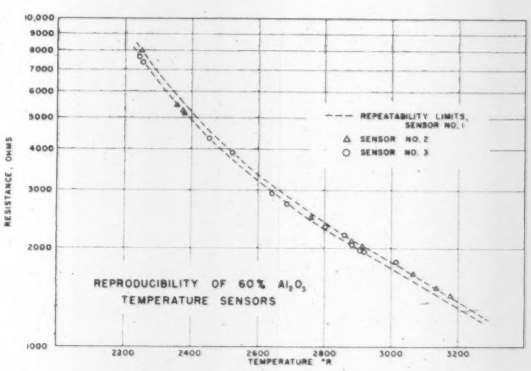


FIG. 7. **REPRODUCIBILITY** of 60% Al_2O_3 temperature sensors.

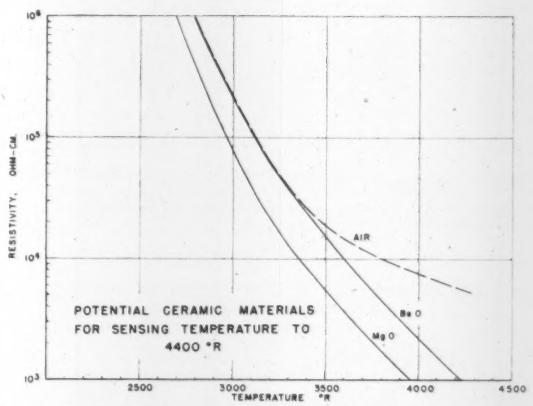


FIG. 8. **POSSIBLE** ceramic materials for sensing temperature to 4400°R.

ductance of air at elevated temperatures.[3, 7, 8] As the temperature sensor is a resistance element, the air surrounding the lead wires can act as a shunt, leading to resistance readings lower than that of the ceramic itself. As limited data exists on the electrical conductance of air, tests were conducted to determine the proper spacing of the component parts.

Calibration Data

Using the probe design of Fig. 2, tests were conducted to determine the repeatability of calibration of 60% alumina sensors. The probe was subjected to repeated calibration cycles between 2200° and 3300°R, for 1000 hours (Fig. 5), the probe being subjected to 2200°R ambient temperatures between calibrations. Fig. 5 shows the band within which all the data were obtained. The resistance-temperature characteristic *did not* vary more than ±0.57% of the mean temperature curve over this period of time. The ± 0.57% maximum deviation includes the following variables:

1. Variations of sensor resistance at one temperature
2. Error in readout of the bridge circuitry
3. Errors associated with the platinum-rhodium/platinum thermocouple
4. Error in potentiometer readout of the thermocouple

Knowing the error potential of the last three variables listed above, as well as the maximum over-all variation, it is calculated that the maximum variation in resistance attributable to the sensor at a specific temperature is approximately ±0.30%. In this figure is also seen the sensitivity of the ceramic sensor, having a change of resistance of 2.4 ohms per degree R at 3000°R. This amounts to 1.3% resistance change in ten Rankine degrees.

The last 200 hours of this calibration were conducted with the Cook-designed bridge circuitry (Circuit B of Fig. 3) employing 60-cps input frequency. When the 60-cps data were corrected for the frequency shift from 1000 cps, these data also plotted within the band shown in Fig. 5.

Sensor Reproducibility

Reproducibility of calibration from one probe to another then was investigated. Additional sensor rods were purchased, the time between purchases of the first and second sets being approximately four months. This time period precluded the material being from the same batch by the manufacturer.

The results of tests conducted on two additional probes are shown in Fig. 7, the data being plotted with the band of the original sensor as shown. Figs. 5 and 7 show that vitrified ceramic oxides are not only repeatable but reproducible.

Tests also were conducted on high-purity alumina. The use of high-purity materials imposes more severe problems on probe design due to increased possibility of contamination of the ceramic oxide, with consequent calibration shift. Another problem with the high-purity materials is their increased resistivity. This predicated a much reduced length between the lead wires. Two alumina sensors were subjected to limited testing (Fig. 6). The same variables existed

in the circuitry as discussed previously. It was calculated that the variation in resistance attributable to the sensor is of the same magnitude as that of the 60% alumina—namely, ±0.30%. Note the extreme sensitivity of high-purity alumina, which at 3200°R is 170 ohms per degree Rankine out of 15,000 ohms. This is equivalent to 1.13% change in resistance per degree Rankine. The reproducibility band between the two sensors was 0.95% maximum in the mid-temperature range.

Therefore, it is seen that the extremes of purity of alumina appear to be repeatable and reproducible as temperature sensors. Further investigation on intermediate percentages of purity of alumina is aimed toward reducing the problems of contamination and high resistance. It is believed that intermediate percentages of alumina concentrate will exhibit repeatability and reproducibility of ±0.30% and ±0.75%, respectively.

Higher Temperatures

Concerning the extension of this work to higher temperatures, the major problem area here is the shunting effect of air. In Fig. 8 it is seen that the resistivity of beryllia coincides with the air gap resistance up to 3300°R, the resistance of air then decreasing at a lesser rate. A similar, but not as severe a problem exists with magnesia. However, by alloying these materials with lower resistivity oxides, it is believed that temperature sensors to 4400°R are possible.

Applications

Resistance-temperature sensors embodying the basic concepts discussed above have many advantages over thermocouples. First, being resistance elements, they require no cold-junction compensation. Secondly, this type of sensor exhibits extremely high sensitivity, much higher than comparable metallic resistance elements, Thirdly, the repeatability and reproducibility of these sensors are equivalent to thermocouples of this temperature range, but are not plagued with shift in calibration over extended use.

Sensors of this type, such as shown at the beginning of this article, have ready usage in industrial temperature measurement and control applications in the 2200 to 3300° R range. As the temperature probe is all-ceramic, no special adjustments, cleaning, or auxiliary equipment (such as air or water-cooling) is required. The probe has been designed to withstand heavy industry environments.

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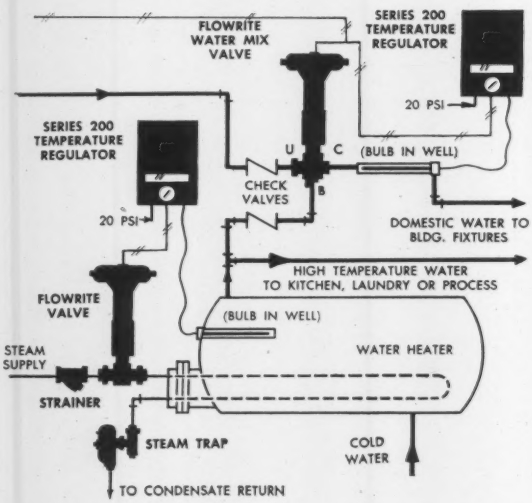
TWO-TEMPERATURE HOT-WATER SYSTEM USES WATER-MIX VALVE

Where hot water is required at two temperature levels (such as 180°F for laundry or process use and a lower level for general use) the system shown satisfies the need.

The equipment consists of two temperature controllers and control valves. One valve controls the steam supply to the water heater. It receives a modulating air pressure signal from a pneumatic temperature controller having a gas filled bulb in the storage tank to sense the water temperature. The valve is single-seated for tight shut-off. This instrument controls the temperature of the high temperature water.

After leaving the water heater, the high temperature water is divided into two branches. One is the high-temperature supply; the other one goes through a water-mix valve where it mixes with cold water. A gas filled bulb in the output line from the mix valve senses temperature in this line and an air pressure signal from the second controller modulates the water mix valve.

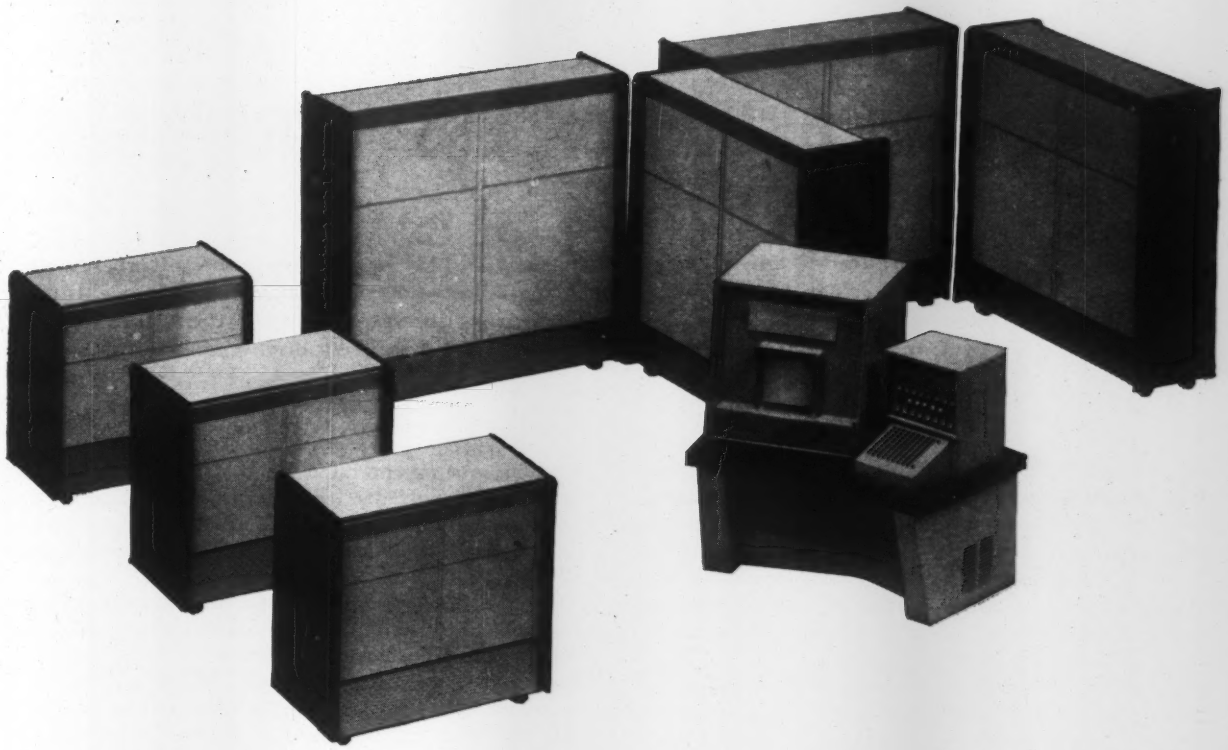
Equipment used: Two temperature controllers, Series 200, Flowrite characterized V-port control valve;



Flowrite water mix valve; accessories.

Source: Powers Regulator Company, Skokie, Ill.

LFE's new RD-900 system--



. . . provides a random access file of up to 495 million bits with access to information in less than 3/10 of a second.

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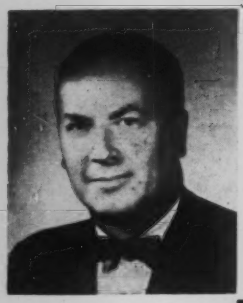
C. E. MATHEWSON
Statham Instruments, Inc.



THE "DIMENSIONLESS" STRAIN-GAGE

High accuracy, long-term stability, insensitivity to temperature effect, ruggedness and lower cost result from a major advance in strain-gage design. "Dimensionless" design features a principle which eliminates many of the critical aspects of finite distances and dimensional stability in conventional gage configurations.

A CRITICAL aspect in the design and application of strain-gage transducers is drift caused by variations in temperature. This effect results from (1) dimensional instability between the fixed and movable points in transducer structures, and (2) changes in resistance of the strain wire elements. The Statham "Dimensionless" principle cancels effects which occur along the axis of the unbonded strain wires in conventional gage designs. The design reduces manufacturing costs because extensive temperature compensation is unnecessary. It also permits the relaxation of other manufacturing tolerances which formerly were critical.

Referring to Fig. 2A, a length of strain-sensitive resistance wire is stretched between the moving point *a* and the fixed point *b*. When point *a* moves, the wire changes in length and a resistance change occurs, producing an electrical signal from the bridge circuit in which the wire is connected.

There are several problems inherent in this conventional design. Point *a* must be restrained from moving far enough to break the wire or exceed its limit of elasticity. The wire must have an initial tension carefully controlled to give it exactly the correct operating tension when it has been heated by the excitation current. This tension is subject to instability due to dimensional changes between points *a* and *b*, caused by variations in temperature. The basic source of trouble is the finite distance between points *a* and *b*. This source of trouble is eliminated in the "Dimensionless" strain-gage transducer.

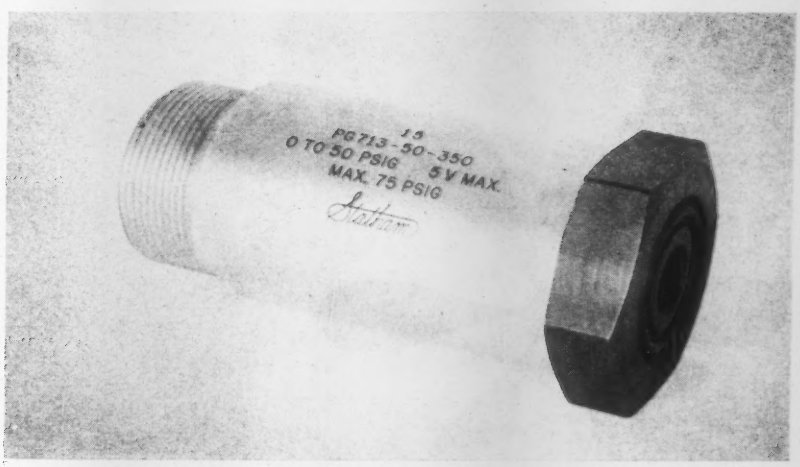
The new unbonded strain gage has been designated "Dimensionless" because the wire is not stretched between a moving and a fixed point. Instead, the moving and fixed points are located in close proximity and are effectively superimposed along the longitudinal axis of the strain wire elements. This is shown in Fig. 2B.

Point *a* is the moving point whose position is to be measured in relation to point *b*, which is fixed. Point *c* is *free*, but is rigidly attached to a load (*m*) which functions to keep the wires taut. Both strain wires are soldered at point *c*. When point *a* moves, the load (*m*) is transferred smoothly from one-half of the strain wire to the other, and the gage elements (*ac*) and (*bc*) change strain equally and oppositely, producing equal and opposite changes in resistance. Electrical connections are made at *a*, *b*, and *c*, so that the gage elements (*ac*) and (*bc*) operate in tension-compression.

The sum of the forces in the two gage elements is a constant and is always equal to the force exerted by load (*m*). If the load (*m*) is slightly less than the elastic limit of a single strain wire, then the strain wire element is protected against damage in the event of over-travel of point *a*.

Within the operating range of the gage, point *c* always moves exactly half as far as point *a*, until all the weight of load (*m*) has been transferred from one wire to the other. The value of load (*m*) merely controls how far point *a* will move before a complete transfer takes place. For practical design purposes, a constant-force spring is substituted for load (*m*) as shown in Fig. 2C.

Fig. 2D shows how the "Dimensionless" principle is applied in the Statham P700 Series transducer (Fig. 1). The four strain wires constitute the active legs of



TRANSDUCER

FIG. 1. **STATHAM** Model P713 industrial transducer

a bridge circuit, as shown in Fig. 3. Downward movement of the diaphragm reduces tension of legs (ac) and ($a'c'$). The forces involved are proportionally transferred, increasing the tensions of legs (bc) and ($b'c'$).

Since points a, b, a' and b' are located in close proximity along the axis of the strain elements, and since points c and c' are maintained at a constant tension which is independent of their distances from points a, b, a' and b', expansion and contraction of the transducer structure does not affect the stresses applied to the strain wires. In addition, stress changes at points c and c' tend to cancel out because the resulting changes in resistance are equally distributed in opposite legs of the bridge circuit. This latter effect also balances out changes in the strain wire which may be caused by environmental temperature and self-heating produced by the excitation current.

The P713 transducer is shown in Fig. 1. Specifications of the P713 include:

Ranges: from 0-5 to 0-5000 psig.
Over-range limits: 300% to 100 psig 200% in ranges to 1500 psig; 150% in ranges to 5000 psig.
Output: 25 mv full scale with 5-v excitation and 350-ohm bridge.
Non-linearity and Hysteresis: ±0.25% full scale.
Thermal Zero Shift: Less than ±0.01% full scale/°F from −65°F to +250°F.
Thermal Coefficient of Sensitivity: +0.005%/°F from −65°F to +250°F.
Resonant Frequency: 3500 cps.
Vibration and Shock Sensitivity: Less than 0.03% full scale per g.

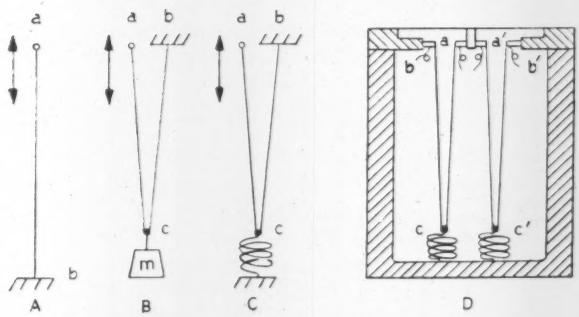


FIG. 2. **EVOLUTION** of "dimensionless" strain-gage transducer. As shown at B, wires **ac** and **bc** are rigidly attached to the load (or spring) at point **c**. Hence, as **ac** stretches, **bc** shortens.

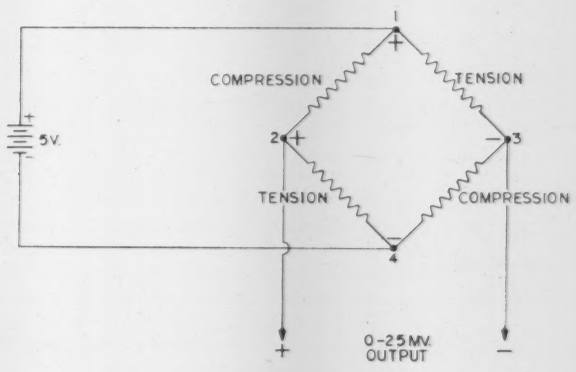


FIG. 3. **BRIDGE** circuit of Model P713.

HOW SHOULD YOU EVALUATE POTENTIOMETER ACCURACY?

Accuracy in an instrument is more than a matter of how closely measured values correspond to true values. Some potentiometers, for example, may be capable of sky-high accuracy—but only under ideal laboratory conditions. Other potentiometers may deliver consistent high accuracy . . . higher than you actually need . . . with the penalty of excessive cost.

A realistic evaluation of potentiometer accuracy, then, involves consideration of stability and reproducibility as well as stated limits of error. By these criteria, Rubicon potentiometers, galvanometers and bridges should be YOUR choice.

By any measure, the new Rubicon 2746 *portable* potentiometer is an outstanding instrument. Ranges 0—1.601 and 0—0.1601 volts. Limits of error are constant, realistic, usable: high range—30 microvolts or 0.03% of reading, whichever is larger. Low range—3 microvolts or 0.045% of reading, whichever is larger. Depend on it for *consistent* accuracy. **Write for Specification Sheet RS-2746, for details.**

Rubicon accuracy stems from a long tradition of engineering excellence and a pride of craftsmanship that is not easily found these days. You can sense this about Rubicon instruments, even before you put them to work. And today the Rubicon tradition of the finest in measuring instruments is being perpetuated by both small refinements and major advances in design . . . to make the best even better. The complete line of Rubicon instruments is available through any of the Honeywell branch offices across the nation.

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High-Speed Three-Color Pyrometer

FIG. 1. G. A. HORNBECK adjusts the focus of the high-speed ratio pyrometer.

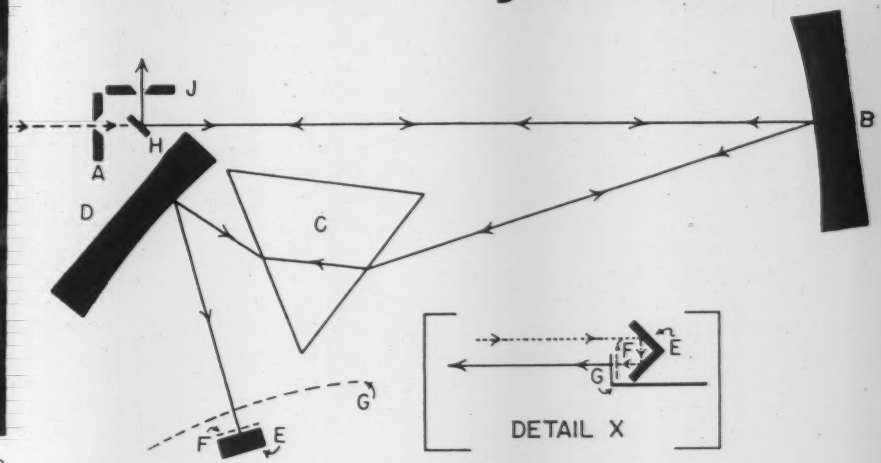

FIG. 2. OPTICAL SYSTEM of the high-speed three-color pyrometer.

A THREE-COLOR PYROMETER, capable of making 1000 temperature determinations every second, has been developed by G. A. Hornbeck of the National Bureau of Standards. The device will be especially useful in the measurement of rapidly-changing temperatures. Fig. 1 shows a prototype that can make 1000 individual temperature determinations per second in the temperature range 1000 to 3000°C with an uncertainty of about 1%.

The instrument forms a spectrum of the radiation from the source, masks out all but the three required wavelengths, and presents these wavelengths to the detector sequentially. When operating at high speed, it is necessary to record the data with an oscilloscope, magnetic tape, or other high-speed recorder.

Certain limitations inherent in one- and two-color pyrometers have been eliminated in this instrument. Brightness temperatures measured with one-color pyrometers can be converted to true temperatures only if the spectral emissivities of the materials being observed are known. To avoid dependence upon knowledge of absolute values of emissivity, two-color or ratio pyrometers have been used. A limitation is once again encountered—the emissivities at the two wavelengths must be identical. Unfortunately, this is not always the case. When three wavelengths are used, true temperatures can be obtained if the emissivities are a *linear function* of the wavelengths selected. This criterion is generally true in the near-infrared region of the spectrum.

In the instrument, radiation from the source of interest passes through an entrance slit (A in Fig. 2) and is rendered parallel by a collimating mirror (B). The beam then passes through a prism (C) and the resulting spectrum is brought in focus with a second mirror (D). The major feature of this optical system is a right-angle mirror (E, see detail X) placed in the vertical plane of the spectral image. As a result of reflection from this mirror, the image is displaced vertically, and retraces its path back through the optical system. A mirror (H) placed near (to right of) the entrance slit reflects the returning beam to a radiation detector. A mask (F) is placed in the path of the beam coming from the right-angle mirror to pass the selected wavelengths. A rotating slotted chopper (G) produces a sequential exposure to the detector tube.

Because the sensitivity of most fast radiation detectors is wavelength dependent, adjustable attenuating pins are placed in the band pass for each wavelength and set to pass the correct amount of radiation at the time of calibration.

The mechanical adjustments necessary to change to different wavelengths are inconvenient at present, and provision is being made to set the desired wavelengths by dial. A suggested set of wavelengths which would give acceptable sensitivity and avoid atmospheric absorption in the infrared has been calculated to be 1.1, 1.6, and 2.1 microns.

1. "A High-Speed Ratio Pyrometer," G. A. Hornbeck, to appear in Vol. 3, *Temperature, Its Measurement and Control in Science and Industry*, Reinhold Pub. Co.

Thermocouples for High Temperatures

JAMES A. BARD J. Bishop & Co.

CONSIDERABLE ATTENTION has been given to measuring high temperatures with special thermocouples. The widely-used platinum *versus* 10% rhodium-platinum thermocouple, as well as the platinum *versus* 13% rhodium-platinum thermocouple, can be used for continuous service to 2600°F in an oxidizing atmosphere, provided it is properly insulated with aluminum oxide or other suitable high-purity refractory. Short-term service between 2600°F and the melting point of platinum (3217°F) also is possible, but leads to deterioration of the pure platinum leg.

To allow improved life of thermocouples for continuous service in the range of 2600°F to about 3100°F, rhodium alloys have been substituted for the pure platinum (negative leg) and the rhodium content has been increased in the positive leg to produce a satisfactory electromotive force. Examples of such combinations are as follows:

5% rhodium-platinum *vs* 20% rhodium-platinum
6% rhodium-platinum *vs* 30% rhodium-platinum
20% rhodium-platinum *vs* 40% rhodium-platinum

The National Bureau of Standards is currently preparing a standard calibration for the 6% rhodium-platinum *vs* 30% rhodium-platinum thermocouple. When this is available, more extensive use of this combination for the temperature range of 2600°F to 3100°F is expected.

Thermocouple combinations containing *iridium* and *iridium-rhodium alloys* have been proposed for continuous service to about 3600°F. The iridium-rhodium alloys usually contain between 40 to 60% rhodium and allow a suitable electromotive force when coupled with pure iridium. Since aluminum oxide is not recommended above 3200°F, such thermocouples frequently are insulated with beryllium oxide. Both legs of these thermocouples are quite brittle and require careful installation to avoid sharp bends or rough handling.

Still higher temperatures can be measured with thermocouples of tungsten *vs* rhenium and tungsten *vs* tungsten-rhenium alloys, as long as the working area is maintained in vacuum, or in inert or reducing atmosphere. Beryllium-oxide insulation is recommended to about 4000°F. Experiments in vacuum to temperatures approaching 5000°F have been performed with bare thermocouples, since even beryllium oxide becomes conductive in this range. Furnaces for service to 5000°F contain tantalum and molybdenum baffles and water-cooled jackets instead of conventional insulation.

Research is constantly in progress to further extend the temperature ranges which can be measured with thermocouples, and to improve the accuracy of measurements in high-temperature service.

Measurement of Hypersonic Flow

HOT-WIRE PROBES have been used for a number of years to measure the mean properties of a fluid stream. The hot wire is capable of providing two thermodynamic measurements: (1) the rate at which heat is transferred from the wire to the stream, and (2) the wire recovery temperature for zero heat transfer. If sufficiently accurate relations are known for the heat loss and recovery temperature as a function of the properties of the flow, only one additional thermodynamic measurement is necessary to uniquely specify the flow field.

Measurements have been made of the heat loss and recovery temperature of a fine hot-wire at a nominal Mach number of 5.8. Data were obtained over a range of Reynolds numbers in the transitional regime, corresponding to free-stream Knudsen numbers between 0.4 and 3.0. At high Reynolds numbers, the heat transfer data agree well with the results of Laufer and McClellan which were obtained at lower Mach numbers. At the lower Reynolds numbers, the results indicate a monotonic transition between continuum and free-molecule heat-transfer laws. A comparison was made between the present recovery temperature measurements and previous investigations by using end-loss corrections appropriate to transitional flow. The normalized variation of recovery temperature for supersonic and hypersonic flow is shown to be a unique function of the free-stream Knudsen number.

Preliminary measurements were made of local Reynolds numbers and stagnation temperature in the wake of a transverse cylinder to illustrate the applicability of the steady-state hot-wire to such investigations.

Abstracted from "Hot-Wire Measurements in Low-Reynolds-Number Hypersonic Flows," by C. Forbes Dewey, Jr., Guggenheim Aeronautical Laboratory, California Institute of Technology, Pasadena, California. Presented at the American Rocket Society 15th Annual Meeting, Shoreham Hotel, Washington, D. C. December 5-8, 1960.

8 MATCHED PRECISION COAXIAL ATTENUATORS

Covering the frequency range from DC to 12.4 KMC

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This set was specially designed for use as working standards in laboratories, and inspection and quality control departments. It includes Weinschel Model 50 attenuators and Weinschel Model 210 attenuators in attenuation values of 3, 6, 10 and 20 DB covering the frequency range of DC to 12.4 KMC. These attenuators, which are supplied in a solid walnut, velvet-lined case, offer the following exclusive Weinschel features:

MAXIMUM STABILITY

Because Weinschel film resistors are used, these attenuators are extremely stable even under peak pulse power and temperature and humidity cycling.

STAINLESS STEEL CONNECTORS

To give maximum life with minimum wear, these attenuators are equipped with stainless steel connectors, eliminating corrosion and plating chips while giving long years of useful life.

CLOSE CONNECTOR TOLERANCE

To assure proper mating of the connectors, the critical dimension of the inner contact depth is held to ± 0.005 inches, even closer than NBS requirements for testing.

CERTIFICATE OF CALIBRATION

A plastic laminated Certificate of Calibration showing calibration data for each attenuator is supplied with the set. The certificate gives DC resistance and insertion loss at 3 frequencies for each attenuator.

Write for Weischel Engineering Bulletin 333 for full information and prices on the AS-1 attenuator set. For special attenuators to meet other requirements, contact our Application Engineering Department.

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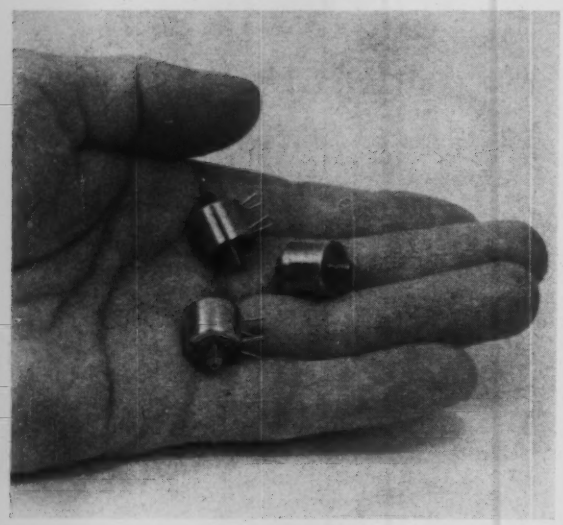


Variable-Reluctance Pressure Transducers

VARIABLE-RELUCTANCE pressure transducers, particularly the "diaphragm" type, possess a number of important features:

1. Ability to withstand severe shock and vibration environment.
2. Extreme overload tolerance (operator proof).
3. Dynamic response for liquid as well as gas systems due to high natural-frequency, low internal-volume, and low volumetric displacement.
4. Ability to accept corrosive media for pressure differential as well as gage-pressure measurements.
5. High signal output level.

Theory of Operation

The diaphragm-type variable-reluctance pressure transducer is shown in simplified form in Fig. 1. A diaphragm of magnetically-permeable material, supported between two symmetrical E core inductance assemblies, completes a magnetic circuit with each E core. The diaphragm deflects when there is a difference in pressure between the two input lines. This increases the gap in the magnetic flux path of one core, and decreases the gap equally in the other.

The magnetic reluctance varies with the gap, determining the inductance value, so that the over-all effect of diaphragm motion is a change in inductance of two coils (L_1 and L_2 in Fig. 2).

The inductance ratio L_1/L_2 is conveniently measured in a bridge circuit (Fig. 2) which produces an output voltage proportional to the pressure difference. Two legs of the bridge are formed by the two E core coils (L_1 and L_2), the other two by R_1 and R_2. The bridge is driven by an a-c source.

The diodes in the resistive voltage divider shown in Fig. 2 permit the bridge to operate only on half cycles (Fig. 3). During one half cycle the diodes conduct, establishing a potential at point B. During the other half cycle, the diodes do not conduct, and there is no output. Thus the output is half-cycle pulses. When the voltage at point A equals that at point B, the output is zero. When the potential at A is greater than that at B, the output has one polarity (+); when A is less than B, the output polarity reverses (−).

In typical pressure transducers, $\Delta L/(L_1 + L_2)$ is usually 5% at full scale, and the corresponding output voltage is 50 mv per volt of excitation.

Greater output can be achieved by using a four-

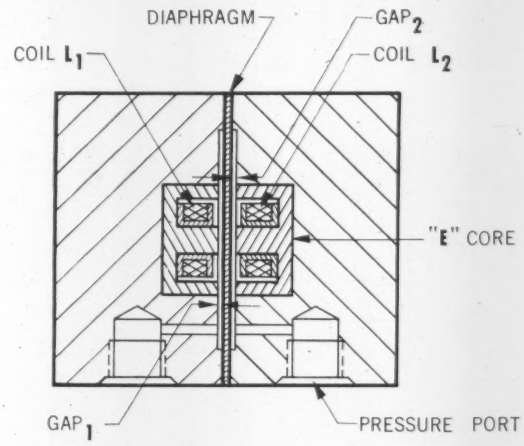


FIG. 1. DIAPHRAGM-TYPE variable-reluctance pressure transducer has two coils, L_1 and L_2. The only moving part is a stiff metal diaphragm between the coils, which moves only a few thousandths of an inch.

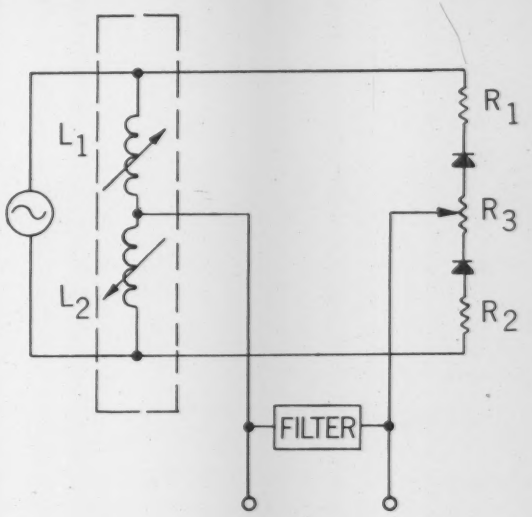


FIG. 2. TRANSDUCER (L_1 and L_2) in half-cycle bridge.

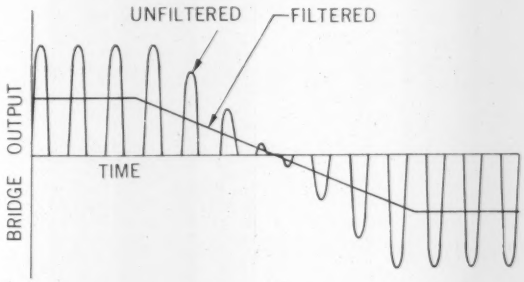


FIG. 3. BRIDGE OUTPUT with pressure reversal, showing half-cycle action and phase reversal. Straight line is filtered output.

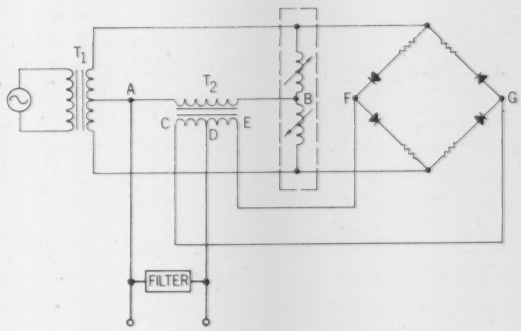


FIG 4. RING demodulator circuit.

diode full-wave-rectifying circuit (Fig. 4). In this "ring" demodulator circuit, the transducer is excited from the center tapped secondary winding of transformer T_1. The A-C output signal appears between the center tap A of T_1 and the common point B of the transducer coils, and is delivered to the primary winding of output transformer T_2. The demodulated output signal appears between A and center-tap D of the output transformer.

The action of the four-diode ring circuit is as follows: Assume point A is at zero or ground potential. Due to diode switching action, points F and G are at zero voltage alternately with each half cycle, and determine the corresponding condition at terminals C and E at output transformer. The effect is to produce a full-wave-rectified voltage at D, the polarity of which reverses with reversal of the transducer output signal phase.

Manufacturing tolerances preclude exact matching of L_1 and L_2 at zero pressure, and potentiometer R_3 is necessary to null the output at zero pressure. The circuit is insensitive to effects of reactive unbalance in the transducer.

A filter (Fig. 2) in the output circuit removes the pulsation to produce the continuous output vs pressure differential curve shown in Fig. 3. The filter also removes undesirable harmonics. The characteristics of this filter are critical; they determine, in part, the bandpass of the system. The maximum bandpass theoretically possible in such a system is 50% of the excitation frequency, although a generally-accepted value is 20%. The filter selected should have a steep cutoff beyond the upper limit.

Bridge output (E_o) is proportional also to the amplitude of the excitation voltage E_i:

$$E_o = E_i(\Delta L)/(L_1 + L_2)$$

where E_o = output voltage and E_i = excitation voltage.

HYDRAULIC SUPPLY REGULATION

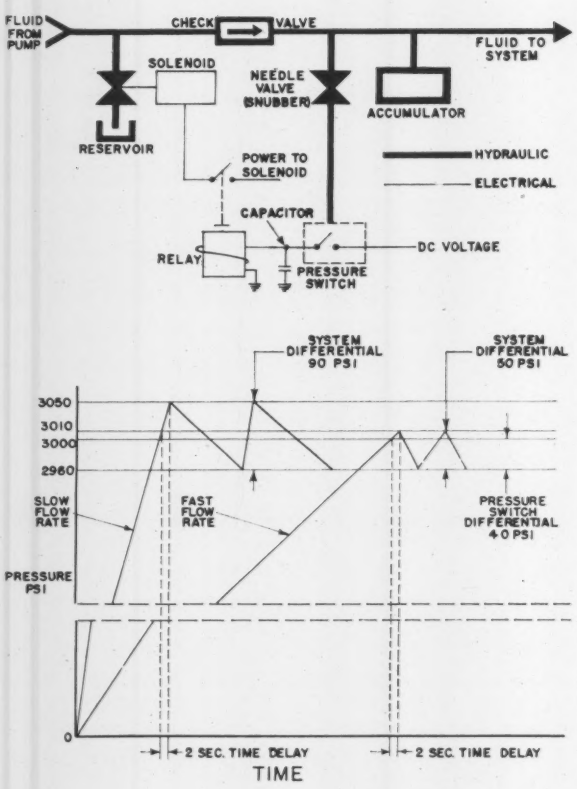
INEXPENSIVE HYDRAULIC POWER SUPPLY REGULATION TO 1.5% USES PRESSURE SWITCH WITH DAMPING NETWORK

The designer often is confronted with the problem of how best to regulate the pressure of a hydraulic system. Although several methods, such as pressure-compensated pumps, unloading valves, or relief valves are available to him, perhaps the simplest and most straightforward is the familiar pressure switch and solenoid valve arrangement. Generally, in this configuration, a pressure switch activates a solenoid valve which directs oil either to the system or to a reservoir, depending on system demands, with an accumulator supplying the system between pumping cycles. Such systems are normally capable of pressure regulation in the order of 10%. With some elaboration, as discussed in the following, it is possible to achieve a regulation capability of 1.5% to 3.0%, which is adequate in many applications.

In the pressure-switch-solenoid system, pulsations of the system pump can produce pressure-switch "chatter," which results in over-all system oscillation. To eliminate this, a snubber is placed in series with the pressure switch. Assuming a pressure switch having an operating differential of 200 psi, so much snubbing may be required to prevent chatter that the resulting system differential may attain 300 psi, or even 400 psi. In a 3000-psi system, this would represent regulation of not better than 10%. Using a switch having a smaller pressure differential makes it impossible to achieve a balance between good regulation and no oscillation. That is, where snubbing action alone is used, the result may be either violent chatter or no operation at all.

One successful approach to the problem has been to supplement the snubber with a damping network, as shown. A relay-capacitor network is introduced between the pressure switch and the solenoid. This built-in time delay prevents actuation of the solenoid until the pressure switch has passed through the "chatter region."

The response curves show that in a system equipped with a damping network having a time constant of two seconds, and a pressure switch with a rated operating differential of 40 psi, the over-all system pressure differential is greater at low flow rates than it is at high rates. The system shown is therefore capable of regulation at from



1.5% to 3.0%, depending on the flow rate. Another possible disadvantage is that if the requirements are such that high flow rates are required for short bursts of less than two seconds, a "pumping up" action may occur, resulting in excessive pressure rise. Although the system would be inadequate in this case, it is felt that this situation is not likely to occur.

Source: Robert D'Entremont, Engineering Hydraulic Laboratory, Raytheon Co., Aero/Weapons Division, South Lowell, Mass.

R. F. LANDER
Electronic Engineering Company of California

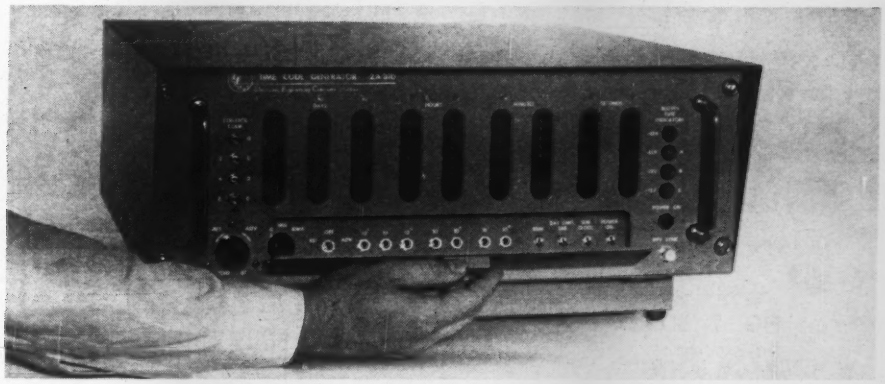


FIG. 1. TIME-CODE Generator (EECO 810) similar to unit now in operation at NBS Radio WWV, supplying time codes on world-wide broadcast.

Electronic Timing

Electronic timing equipment must be used for precise timekeeping and synchronization of equipment separated by large distances. Primary use is in correlation of data taken at several sites.

EARLY TECHNIQUES for timekeeping included the pendulum, the synchronous motor, and the chronograph using a rapidly rotating drum on which timing marks were made by a tuning fork. Modern science, however, requires more precise timekeeping and time recording devices, including synchronization of instrumentation and timing equipment over distances of thousands of miles. This has led to the development of electronic timing equipment.

A single camera or plotting board may require only one time-signal generator hardly more complex than an electronic chronograph. The "clock work" usually comprises a stable oscillator and the necessary circuitry to divide down the frequency into the signals required for timing purposes.

In contrast, a large system complex such as that installed at the Atlantic Missile Range at Cape Canaveral and down range will include a *Central Time-Code Generator,* many slave *Time Generators,* and scores of *Terminal Timing Units* to serve each of the instrumentation sites. Such sites also may have radars and plotting boards, theodolite systems, telemetering ground stations, and various other types of instrumentation.

Master Time Generator

The Master or Central Time Generator (Fig. 2) provides time signals and time codes for local instrumentation and produces precision synchronizing signals for remotely located slave time-generators. A precision frequency standard generates the basic frequency for the system. A pulse rate divider, making use of digital division techniques, produces the various pulse rates required throughout the system. The various time codes are generated by counting pulse rates into accumulators, and scanning the count in these accumulators periodically to produce the desired codes.

Frequency Standard

In a typical Master Time Generator, the basic frequency may be produced by a 1-megacycle frequency standard. A precision oscillator with frequency stability of $\pm$ one part in 10^9 per day is not unusual.

For some types of frequency standards, synchronization is maintained between the local standard and the WWV standard time-transmissions. One method (low accuracy) is to aurally zero-beat the note of the WWV receiver against high-order harmonics of the

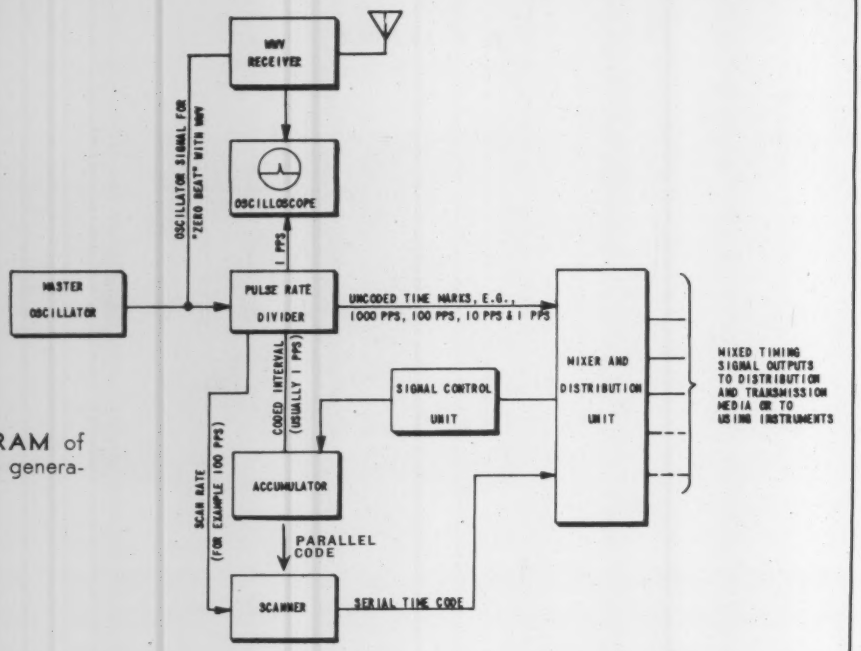

WWV RECEIVER
OSCILLOSCOPE
OSCILLATOR SIGNAL FOR "ZERO BEAT" WITH WWV
1 PPS
MASTER OSCILLATOR
PULSE RATE DIVIDER
UNCODED TIME MARKS, E.G., 1000 PPS, 100 PPS, 10 PPS & 1 PPS
CODED INTERVAL (USUALLY 1 PPS)
SIGNAL CONTROL UNIT
MIXER AND DISTRIBUTION UNIT
MIXED TIMING SIGNAL OUTPUTS TO DISTRIBUTION AND TRANSMISSION MEDIA OR TO USING INSTRUMENTS
SCAN RATE (FOR EXAMPLE 100 PPS)
ACCUMULATOR
PARALLEL CODE
SCANNER
SERIAL TIME CODE

FIG. 2. BLOCK DIAGRAM of timing-signal (time-code) generator.

frequency standard. Another method (high accuracy) involves comparing a 1-pps output from the pulse-rate divider with the WWV 1-pps signal on an oscilloscope. For still higher accuracy, the phase of the local oscillator can be compared with the stabilized VLF transmitter carrier of WWVL (new low-frequency transmitter of WWV) or NBA, Panama, C.Z. (Navy low-frequency transmitter) in 10-kc range.

Pulse-Rate Divider

A Pulse-Rate Divider consists of digital dividing circuits which produce various pulse rates required within the system. A Pulse-Rate Divider may be required to provide as many as a score or more of rates ranging from below 1 pps to over 1000 pps for use in certain recording instruments. A range of pulse rates from 1 pulse per day to 10,000 pps or higher is not uncommon.

Code Accumulator

The Code Accumulator counts the code word interval and stores this count in the format of the final desired output signal. For example, if the final code format is to be 17-bit, 100-pps code (Fig. 4), then this Accumulator would count (in binary fashion) 1 second pulses from 0 to 59, then count 1 minute pulses from 0 to 59 and 1 hour pulses up to 23. This would produce the typical 17-bit Hours, Minutes, Seconds code. The code scan rate would be 100 pps.

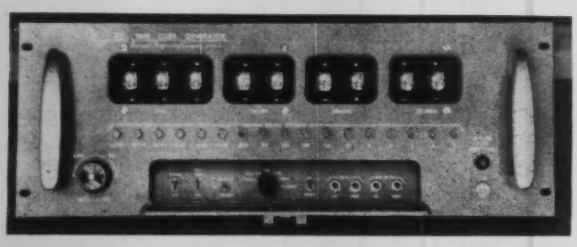


FIG. 3. NEW EECO 811 Time-Code Generator supplies all four IRIG code formats soon to be standardized at major missile ranges.

Scanner

The Scanner produces a serial time code, consisting of width-coded pulses (narrow for zero, wide for binary one). This serial code can be modulated on a carrier for use by instrumentation recording devices such as magnetic tape units, or the level shift signal can be used on high-speed cameras, where a serial presentation is required.

Mixer and Distribution Unit

In many timing systems, composite signals are required; this is the function of the Mixer and Distribution Unit (Fig. 2). For example, it can develop a 1-pps signal followed by its associated code identification, which is subsequently followed by timing marks dividing the remainder of the 1-second intervals into 10ths, 100ths, and 1000ths of a second.

The Mixer and Distributor Unit also produces the necessary number and type of outputs required to distribute the timing signals. For example, there may be several outputs compatible with 600-ohm, voice-type telephone lines, or several outputs which are adaptable to driving low-impedance coaxial-line distribution systems.

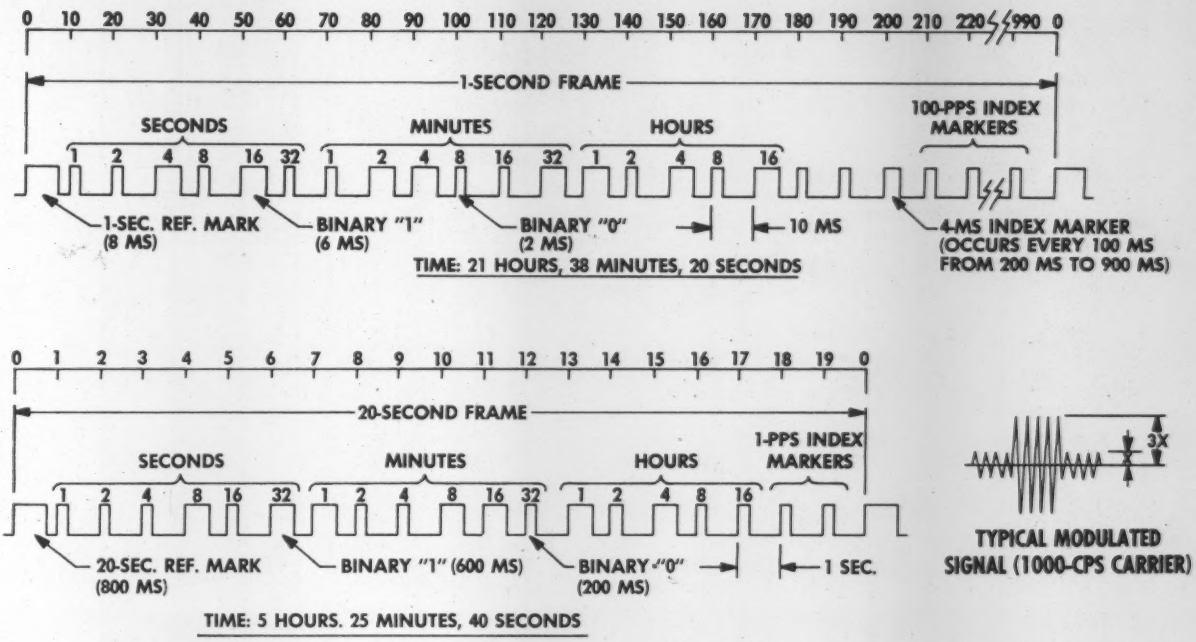

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 990 0
1-SECOND FRAME
SECONDS
MINUTES
HOURS
100-PPS INDEX MARKERS
1 2 4 8 16 32
1 2 4 8 16 32
1 2 4 8 16
1-SEC. REF. MARK (8 MS)
BINARY "1" (6 MS)
BINARY "0" (2 MS)
10 MS
4-MS INDEX MARKER (OCCURS EVERY 100 MS FROM 200 MS TO 900 MS)
TIME: 21 HOURS, 38 MINUTES, 20 SECONDS
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 0
20-SECOND FRAME
SECONDS
MINUTES
HOURS
1-PPS INDEX MARKERS
1 2 4 8 16 32
1 2 4 8 16 32
1 2 4 8 16
20-SEC. REF. MARK (800 MS)
BINARY "1" (600 MS)
BINARY "0" (200 MS)
1 SEC.
TIME: 5 HOURS. 25 MINUTES, 40 SECONDS
3X
TYPICAL MODULATED SIGNAL (1000-CPS CARRIER)

FIG. 4. ONE FRAME of 17-bit, 100-pps second-minute-hour time-of-day code is shown at top. One frame of 17-bit 1-pps second-minute-hour code is shown at bottom. A wide pulse indicates a binary digit—for example, at top left, the third and fifth pulses are wide, indicating 20 seconds in binary (1-2-4-8-16-32) code.

Slave Time-Generators

Although every reasonable precaution usually is taken to keep a precision timing signal system "on the air" from the central point, the possibility exists that the central or master system transmission media could break down. To anticipate this possibility, slave time-generators are operated at or near instrumentation sites in synchronization with the master time-generator (which supplies synchronization to each of the slave systems in the complex). If the transmission medium (land line, radio link, submarine cable) fails, the slave generators will continue to produce time signals to maintain the desired timing accuracy and station-to-station coincidence.

Slave time-generators are essentially the same as master time-generators and contain master oscillators or frequency standards, pulse rate dividers, synchronizing circiuts, etc. The slave time-generators usually are not required to produce as large a number of outputs as is supplied by a master time-generator.

Auxiliary Units

There are usually many auxiliary units to solve special problems. For example, a signal control unit may be used to turn On or Off any given signal from the Mixer and Distributor Unit, and also enable the operator to "set" the Code Accumulator to the proper time of day and then start it in synchronization with the correct standard time or system time.

Many timing systems contain an oscilloscope which is used to set pulse-rate divider circuits containing "Advance-Retard" features to align generated time with a standard such as WWV.

Used directly with the oscilloscope is the WWV receiver which is used to bring the timing center into synchronization with the WWV 1-pps signal. It is used also to assist in setting the Accumulator to the proper "time of day" as well as for initial adjustment of the Master Oscillator frequencies.

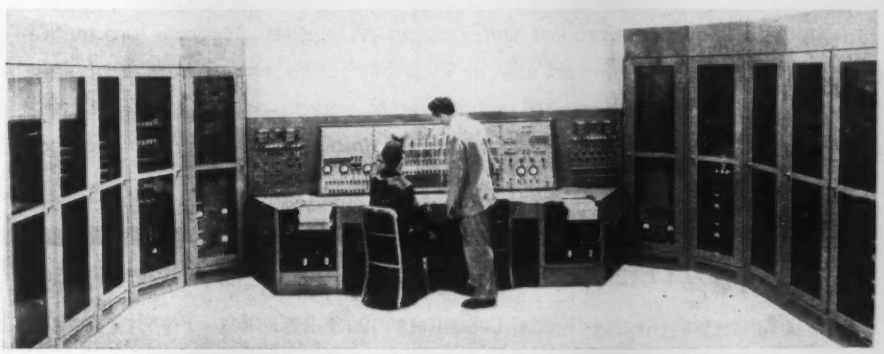
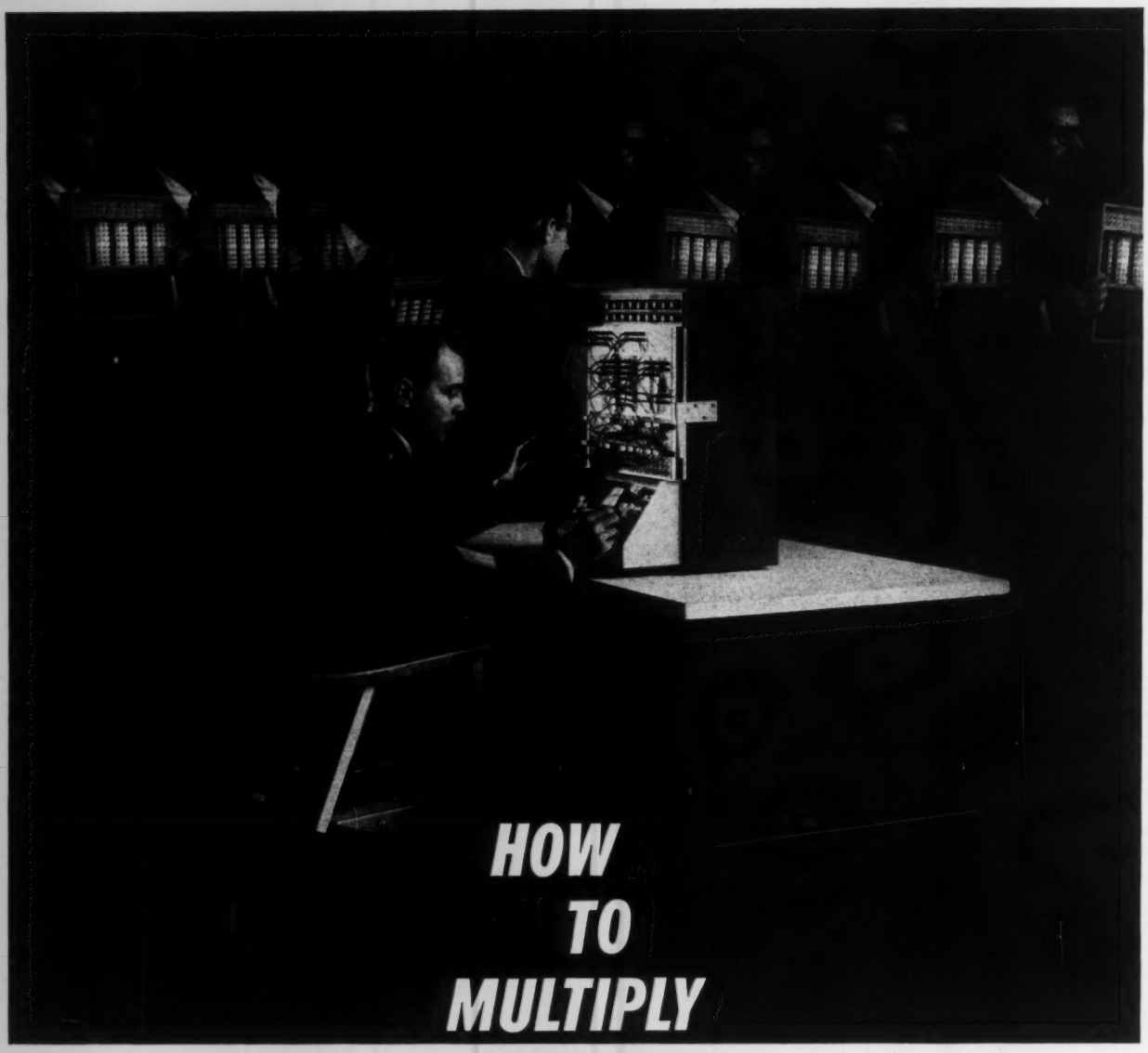


FIG. 5. TIMING-SIGNAL generator for Atlantic Missile Range. This system has operated 24 hours per day since 1954.



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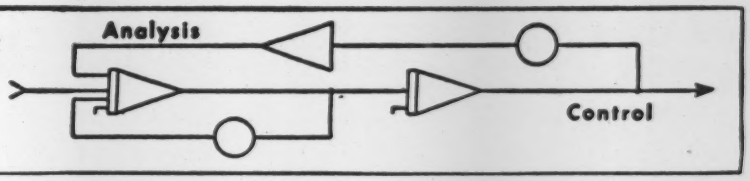

Newsletter

John McLeod, EDITOR
Suzette McLeod, SECRETARY
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Rocky Mountain Simulation Council

Maughan S. Mason, Thiokol Chemical Corp., Brigham City, Utah; Chairman, Steering Committee

BITS

Under **Pieces** we have two meeting reports:

Midwestern Simulation Council, May 15th, Rock Island Arsenal, Illinois, on "Education."

> Milt Warshawsky (Wright-Patterson AFB, Ohio); A. I. Katz (Electronic Associates, Inc.); William B. Field (Union Carbide Olefins Co.); Ralph J. King (Caterpillar Tractor Co.); Robert M. Howe (University of Michigan)

Rocky Mountain Simulation Council, June 27th, Denver, Colorado.

> George Brown (Bendix) on "A Free Turbine Engine for Helicopter Applications"
>
> John Zampino (Martin-Denver) on "The Simulation of Static and Frictional Forces"
>
> Maughan S. Mason (Thiokol Chemical Corporation) on "Determination of True Input"

Plus added attractions: "Analog Techniques—Pulse Circuit by **Tom Anderson**

"Information Without Theory"—Simulmatics

"He Went Thataway!"—**Lad Kovach** Letter to the Editor, from **Jack Sherman**

PIECES

MIDWESTERN SIMULATION COUNCIL MEETING OF 15 MAY ON EDUCATION

Of the May 15th meeting of the Midwestern Simulation Council *Robert T. Harnett*, their secretary, writes in part as follows:

The afternoon tour of Rock Island Arsenal was quite interesting. One of the highlights was an outdoor demonstration of how a self-propelled howitzer can extract itself from a quagmire. The people at Rock Island wanted some sloppy weather just prior to the meeting but dry weather for the day of the meeting. Strangely enough, that's exactly the way it worked out. Another part of the tour consisted of a demonstration of an RCA 501 computer system. Their analog computer is a Goodyear A-14. All of the arrangements for the meeting were handled by Joe Wilson, one of our steering committee members who is on the staff of Rock Island Arsenal, and he did a fine job.

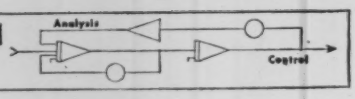
Speaker No. 1: L. Milton Warshawsky, Aeronautical Systems Division, Wright-Patterson AFB, Ohio

Last week Bob Howe and I sat on a panel of the Western Simulation Council discussing the subject, "The Future of Analog Computation." Today our subject is "Education." Our preparation for both meetings was simplified by the fact that both subjects are inextricably intertwined. Without some definite improvement in the area of educating the technical community on the existence and capabilities of analog computation, its future is dim.

It has been obvious to all of us that digital computation has been growing at a rapid rate. We attribute this in part to extensive advertising efforts, often verging on propaganda, which shout the virtues and unlimited applicability of equipments in handling almost every aspect of Man's existence in the future. The "Madison Ave. boys" utilize every conceivable stunt, such as predicting election winners and mating matrimonial prospects, to create in the public eye an image of an infinitely versatile and resourceful giant that will someday relieve the world of all its burdens, including thinking. Of course we all know of the many truly effective applications of digital computers in the areas of business, industry, and science, but some of the material is pure hokum. In the area of analog computation effort, we do not see a commensurate growth in activity. Let's face it—when the word "computer" is mentioned today, people do not ask whether analog or digital is being discussed. They naturally assume digital.

Does this mean that digital computers have taken over the area of scientific computation where analog computers are supposed to excel? If they have, and there is growing evidence that they are encroaching, (real-time digital simulators, for example) we feel that it has been the result of forceful salesmanship rather than merit. In short, it is our considered opinion that we have a good product to sell. The next question is how best to do this. After all, we can't compete with IBM, which budgets $45 million per year for education and advertising, according to information from a usually reliable source.

I would like to report on an effort



recently made at Wright Field to indoctrinate a group of technical supervisory personnel on the capabilities of analog computation. The motivation for this particular program was our observation that only about ½% of the engineers and scientists were availing themselves of our services even though we possess the most advanced and one of the largest facilities of this type in the country. We have deliberately held down the size of our staff to accommodate this workload although our equipment could probably handle three times its present load. On the other hand the Digital Division, right next door to us, has been expanding constantly both in equipment and personnel.

We invited 60 top-level scientific management people to attend this program, which took them away from their jobs for a solid week. They were exposed to approximately 20 hours of lectures and 15 hours of laboratory demonstrations. We enlisted the aid, through a contract, of Electronic Associates in carrying out the program. Al Katz and an assistant were the two principal instructors, although we supplied nine other people full time.

To instrument this program for the purpose of determining its effectiveness, we gave each of the attendees an examination both before and after the course. In addition, upon the conclusion of the program, we submitted a questionnaire to each student soliciting his opinions on various aspects of the course such as means of improving it, estimates of its value to them and their subordinates, etc.

The results of the before and after test showed a marked increase in knowledge of analog-computation principles and applications. The average grade increased from 48.3% to 78.6%. The median grade went from 42% to 85%. The questionnaires revealed an almost unanimous opinion that the course was most valuable in revealing the applicability of analog computers to their problems and that it should be given to all working-level engineers.

An unexpected dividend was received from the before-and-after tests. One section of it was in the form of true-false questions which, quite unwittingly, tested the knowledge of digital as well as analog computers. One question, viz. "Unicode and Fortran are two methods of programming analog computers without the need for preparing schematic diagrams" was answered incorrectly by approximately one person out of three. Thus, in spite of the extensive courses given by IBM and Remington Rand, apparently there is not a widespread understanding of these systems. This gives us hope that we're not too late in starting an educational program, since the uncommitted technical community has not been thoroughly brainwashed as yet.

The questionnaire revealed at least one significant result in that 85% of the responders stated that as a result of attending this course they felt that some of their technical problems were amenable to solution by analog computers.

My purpose is reporting on this program is to point out an effective and relatively inexpensive means of bringing our message to a select and influential group. We intend to continue this program to cover several hundred additional engineering personnel. If other organizations facing similar problems to ours were to get something like this going we could start a ground swell of interest in analog computers that would restore them to their proper position of eminence.

Finally, I would like to propose that Simulation Councils, Inc. and the Midwestern Simulation Council in particular undertake a vigorous program to promote a knowledge of the capabilities of the analog computer among all the scientific disciplines. As a starter they could work out a series of curricula of programs such as the one we undertook and which admittedly is far from perfect. They could collect from many sources useful applications problems. They could undertake an effort to have published in various technical journals appropriate analog-computer application articles. We do not have a pat proposal to cover all aspects of this problem. We'd like to stir up suggestions from other people. I feel that while these bi-monthly meetings of our Council serve a useful purpose, they usually bring out approximately the same people time after time and thus do not result in large numbers of scientists learning what we can do. This would be a worthwhile objective of our organization.

Speaker No. 2: A. I. Katz, Director, Training and Education, Princeton Computation Center, Electronic Associates, Inc.

The Training and Education Group of EAI has been active in four areas of education in analog computation. First, the broad area of *brief introduction to analog computation*. In talks before technical societies, business organizations and schools (including high schools), we find that we must avoid the mathematical connotation—Better not have a mathematician give the show. Relate problems to physical systems.

One- to three-day seminars at a company are also useful. Advance notice is given and interested persons can attend. This gives them a quick picture of what analog computers can do. It is particularly effective if the examples discussed can be taken from their own fields of interest.

The second area is *training for a working knowledge of analog computation*. This is the objective of the Advanced Application Courses presented at PCC since 1957. Illustrate applications to various problem areas. Show people that they can do their own programming and they are no longer afraid of the computer. Keep the illustrative problems dramatic but simple. There are many good books on the market today. Effective programming and check procedures should be emphasized.

The third activity is *training a company's personnel after a computer is purchased*. Maintenance and operator's training becomes most important now. A staff always has a certain turnover and supplemental training is necessary as time goes along. Here we often go out to a facility for one-week concentrated courses. One-week maintenance and one-week operator's courses on EAI machines are provided without charge at PCC. Costs are thus much lower and training is effective since many people can participate in the program. Visual aids are important in this type of activity.

The fourth activity is *expanding the knowledge of your staff so that they see new areas of application* such as partial differential equations, statistical techniques, on-line data reduction, etc. Specialized programs come into play here—usually concentrated 2-3 day courses or seminars. This matter of advancing the knowledge of the staff is very important. Visual aids should be used to as great an extent as possible.

The Training Group at EAI has been active for about four years, but more programs have been given in the

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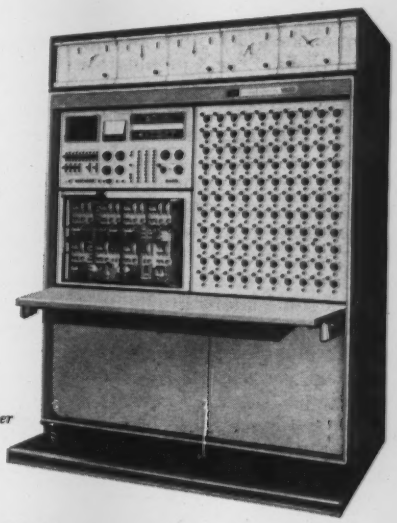

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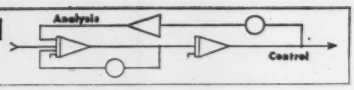

last six months than in the previous four years. This is indicative of the urgent need for training and education. But be wary of a training program that requires your own staff. Most such programs wither away because of "more important work to do."

Another facet of training has been accomplished by the Computation Center itself. The Computation Center was started for people who had a problem and wanted to have it solved. Once on the machines they were often amazed to find out what they could learn from the computer and from computer people. The most successful programs were those where an engineer came in with his own problem, saw how it could be programmed, turned some knobs to change parameters in his problem, and went away with valuable information on his problem. In this process he became acquainted with effective programming and analysis techniques as he worked with PCC engineers—"on the job" training!

Speaker No. 3: William B. Field, Union Carbide Olefins Co., South Charleston, West Virginia

At the Union Carbide Technical Center, we have a fairly major laboratory operation. One of the most prominent characteristics of chemical processes is their evolutionary nature. The demand for a particular product may arrive much faster than anticipated, and it may require large changes in production rates. The opportunities for analog computation lie in reducing the tedious procedure of process improvement. To do this, we try to get the process engineer as close to the analog computer as possible; this requires a training program.

We find that a suitable orientation program along with appropriate demonstrations and practice sessions is the only practical means of administering this specialized training. We suggest that a course of 25-40 hours of instruction be made available to engineers.

Certain conditions must be recognized. The course material should be a clearly defined outline of the system engineering approach through analog computation. The course should prepare a man to analyze his own problems for an analog study. He should develop his own models, prepare circuit diagrams, operate the computer, and interpret results. The instruction should be given during working hours with the permission of the attendees' supervisor.

Classes should consist of 10-15 people and should be scheduled over a few weeks rather than concentrated in a few days. The course should be preceded with information to the supervisors to convince them of the value of this course for their people and the need for temporary shifts in workload. The supervisors should be advised to encourage their people's attempts to upgrade their work through the use of analog computation. We feel that a supervisor sympathetic to such a program is a great asset. A separate briefing session for the supervisors is often desirable.

It cannot be expected that this course will produce a computer expert. It can orient a technical man towards the proper goals and place him in a position to learn more with each new job. Even if he never undertakes a specific computer problem, the course should set him to thinking along new and refreshing lines.*

The analog-computer circuitry should be treated from a fundamental point of view. It is not sufficient to describe summers and integrators, for example, by the conventional triangles and input gain numbers. The functions of the input and feedback circuits should be defined in detail, the objective being to gain the confidence of the project engineer in the validity of the computer results.** By reason of this fuller understanding, he will come back to the laboratory with his problems time after time.

In dealing with management and technical groups, I find value in two quotations that I have used for about six years. The first is from George Philbrick in September, 1955. "If you want results, promote a free interchange of ideas with the analog machine. Odd as it may sound, the computer will frequently make suggestions at an engineering level, when an understanding develops. Take it from me, it can even invent. But not by itself. Above all, be assured that you cannot replace brain power with a computer. No substitute for creative thinking has yet been reported. Nor can the machine convert mediocre technical men into prodigies. *The proper application of analog instrumentation is to extend, to augment, and to liberate the development and creative engineering brain power which is already available in your departments.*"

Another quotation was published by Ernest F. Johnson of Princeton University in March of 1955. "Reasoning by analogy requires extending thought into alien disciplines. The design of a successful analog requires an understanding of the behavior of both the prototype process and the analogous process. It further requires an intelligent reduction of that understanding to useful mathematical form. Such mental exercise serves to integrate much of the engineer's technical background. *There is no more effective tool for stimulating thought than reasoning by analogy, and where it can be used, it provides a most effective aid to technical analysis.*"

*Hear, hear!—Ed.

**Here I don't necessarily "hear." I believe it depends on the person's background and interests.—Ed.

Speaker No. 4: Ralph J. King, Research Department, Caterpillar Tractor Co.

Our needs in engineering and research require a wide coverage of techniques and knowledge from automatic controls to X-ray diffraction. Such subjects as heat transfer, fluid mechanics, servo mechanisms, gas turbine engines, transistor circuitry, and many others are daily subjects of investigation. Over 1500 people are employed in our Research Department.

The biggest competition for computing has been testing—we have extensive laboratory facilities, two proving grounds, and a large active field test group. For many years it has been our practice to build new devices and test them extensively. We are now introducing computing, both analog and digital, to speed these projects up and reduce their cost.

In introducing computing, the initial beginning will probably be the most difficult time. Facilities are justified by accomplishments. But without the facilities it is very hard to have the accomplishments, so some sort of selling program is necessary.

II. Selling Management—Some General Comments

In the initial process of selling a computing facility or in the continuing job of selling the facility, the following points may be useful guides.

1. **Have something worth while to sell! Pick a good project—one that needs doing—one that can be done in a reasonable time at a reasonable cost. Falling flat on your face here could be disastrous.**

J. A. Baker, Operations Group Manager at one of the Boeing Aero-Space Division's EASE® Analog computation laboratories. EASE reliability (actual records: less than 2% down time over 6,592 scheduled hours—20 hours/day, 6 days/week, 44 weeks) helps assure Boeing of meeting commitments on time.

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Making important contributions to the Dyna-Soar design and simulation program is the Beckman EASE Analog Computer facility—one of three EASE installations Boeing uses in research and development activities at Aero-Space Division for Minuteman, Bomarc and hydrofoil programs, and at Transport Division for 707 and 720 jetliner projects.

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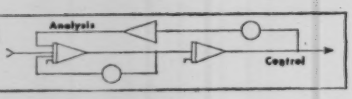


2. Have a sympathetic approach to management—don't be self-righteous. "Anyone can see that this is a good project that needs to be done!" It is management's duty and prerogative to question. Don't be impatient, just because you want to do the project doesn't mean it should be done today. Don't make proposals on a take-it or leave-it basis. Don't talk down to management on technical subjects.
3. Reduce the problem to its main elements. Leave off as many of the qualifications as you can. Take responsibility for the proposal. Don't promise what you can't deliver.

Ralph illustrated his points with 23 slides which showed how they sell their computing facility at Caterpillar.

Speaker No. 5: Robert M. Howe, Dept. of Aeronautical Engineering, University of Michigan

So far, we have heard how you would go about indoctrinating experienced people in the field of analog computation. For myself, I feel that the most effective way to spread the word on the use of analog computers is to do the training when the people are inexperienced engineers in our colleges and universities. At the University of Michigan we first started using analog computers in our courses and laboratories as far back as 1948. At the present time the Aeronautical Engineering Department has available approximately 15 table-top computers with six to ten amplifiers in each. They are for student use in various laboratory courses and, as a result, we have indoctrinated a large number of undergraduate and graduate students in how to apply analog computation to engineering problems.

When we started using analog computers for classroom work and laboratory work we had equipment that we had built ourselves because none was available. The computers were flexible in that input and feedback networks were on external plugs. However, this flexibility led to constant trouble. Now we feel that it is important to have a maximum of programming convenience, such as built-in amplifier summing resistors, even if it means loss of flexibility. Then the student can concentrate on use of the computer for his own problem rather than concentrate on finding mistakes in wiring a plugboard. We feel that an introduction to computers must be made in such a way that students see some results at a very early time.

Another point I would like to make is that I think it's a shame that we haven't been more successful in introducing students to analog computers as compared with digital computers, particularly since there are several basic advantages that we have in selling the use of analog computers. One obvious advantage is that it is easier to teach someone to program an analog computer and to get some useful results in a short time. Secondly, it's a lot easier to get out the results and display them in graphical form. These two advantages need to be exploited by us to a greater degree.

I think there are three general areas where analog computers can be used effectively for academic work. One is the area of the lecture demonstration where you bring the computer into the classroom and show the solution of a problem that you have been discussing. Display could be on an oscilloscope for repetitive operation or on a recorder whose output could be projected onto a screen.

A second area where analog computation can be used is in the laboratory as part of a laboratory course. An example would be a course on automatic control where the student sets up various control problems, learns how to get solutions on the computer, and operates the computer.

The third area would be in the actual teaching of application courses for analog computers. Here the main reason for teaching the course is to show the application of analog computers to a wide variety of engineering problems. All three areas have been used extensively at The University of Michigan, and we would like to see them spread to other colleges and universities. As a result a large number of students will be cognizant of the various areas of application of analog computers, and this will go a long way towards selling management on the capability of analog computer facilities.

I would like to make a brief mention of a program at The University of Michigan which is sponsored by the Ford Foundation for upgrading engineering education through the use of computers. We have been trying to achieve more widespread use in education of both the analog and digital computers. Now nearly all of our 1000-1500 graduating engineers have had contact with both analog and digital computers during their studies. This grant from the Foundation also pays for other educators to visit the University and see how computers are being applied.

There is an additional way that we can promote a more widespread use of analog computers in the technical areas. In some cases, the centralization of computers in a company tends to discourage their use. I would like to argue for small and medium-sized computers spread throughout the engineering departments in addition to the large centralized facility. Thus engineers can become acquainted with the computers for their own small problems and this should stimulate the work in the large centralized computers as well.

ROCKY MOUNTAIN SIMULATION COUNCIL MEETING OF 27 JUNE ON TURBINE ENGINES, STATIC AND FRICTIONAL FORCES AND TRUE INPUTS

The Rocky Mountain Simulation Council held its summer meeting at the Valli Hi Motel (Denver) on 27 June 1961.

Brief résumés of the speakers' remarks follow:

George Brown (Bendix) on "A Free Turbine Engine for Helicopter Applications"

Mr. Brown gave an interesting talk concerning helicopter control system simulation. The group discussion ranged from dynamometer characteristics to methods for obtaining additional thrust on commercial jet airlines. Mr. Brown showed general control circuit simulation diagrams, and discussed the various techniques he used to simulate functions of two variables.

John Zampino (Martin-Denver) on "The Simulation of Static and Frictional Forces"

Charles W. Taylor prepared the information, but was unable to attend the meeting.

John Zampino discussed in some detail circuits used for simulation of frictional forces under various conditions. He also described construction of some low cost diode circuits.

Robert Turner (Lockheed-Sunny-

vale) sketched a circuit providing a hard, sharp limit.

Mr. Zampino indicated that analog check solutions at Martin have normally been performed after the corresponding digital simulations. Since these analog checks often reveal discrepancies between the math model and the physical system desired, the present policy is to obtain the analog solution prior to completion of digital programming. This allows improvements resulting from the analog simulation to be incorporated in the digital program.

Maughan S. Mason (Thiokol) on "Determination of True Input"

Mr. Mason described implicit function techniques useful for analog data reduction.

For the case where physical system response oscillation masks the desired signal, a mathematical representation of the system can be incorporated into the feedback of a high gain amplifier to cancel the undesired oscillation. This has been successfully performed for fourth-order systems.

A derivative feedback term is necessary to achieve stability; differentiation can be avoided through judicious programming.

MAUGHAN MASON

THOMAS ANDERSON

ANALOG TECHNIQUES—PULSE CIRCUIT

Thomas C. Anderson (Lockheed-Sunnyvale)

In the course of a trajectory study, *D. H. Utter* needed a method of marking time on the altitude-distance plot. The serendipitous result was the circuit of Fig. 1. In addition to the desired timing pulse, this interesting application of an unstable loop produces both square and triangular waves.

Amplifier 2 changes polarity when

$$|e_1| > |e_2| \quad \text{or}$$

$$MK\Delta t - K > K$$

$$M\Delta t > 2$$

$$\Delta \approx \frac{2}{M}$$

The time histories of e_1, e_2 and e_3 are as shown in Fig. 2. From this it can be shown that the period of the system is $T = 4/M$ seconds. Thus if $T = 2$ seconds, the positive pulses represent the odd seconds and the negative pulses indicate the even seconds. This signal can be summed with the desired Y signal and put on the Y axis of an XY plotter to provide the timing marks.

Since the frequency is defined by $f = 1/2\Delta t = M/4$, the circuit can be easily made frequency-modulated by putting a variable gain such as a multiplier in the input line of the integrator.

With a slight modification, the same circuit can be made to give square pulses of unequal duration. The necessary change, the addition of a rate bias, is shown in Fig. 3.

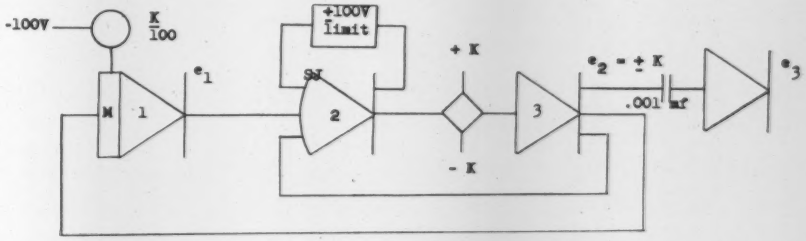


FIG. 1.

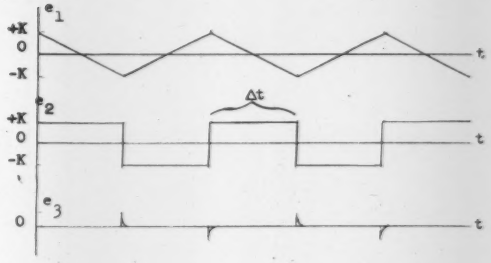
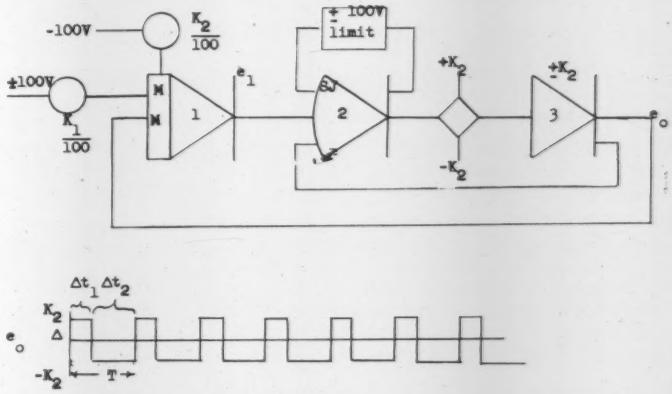


FIG. 2.

FIG. 3.



Where $\Delta t_1 = \dfrac{2K_2}{M(K_2 + K_1)}$

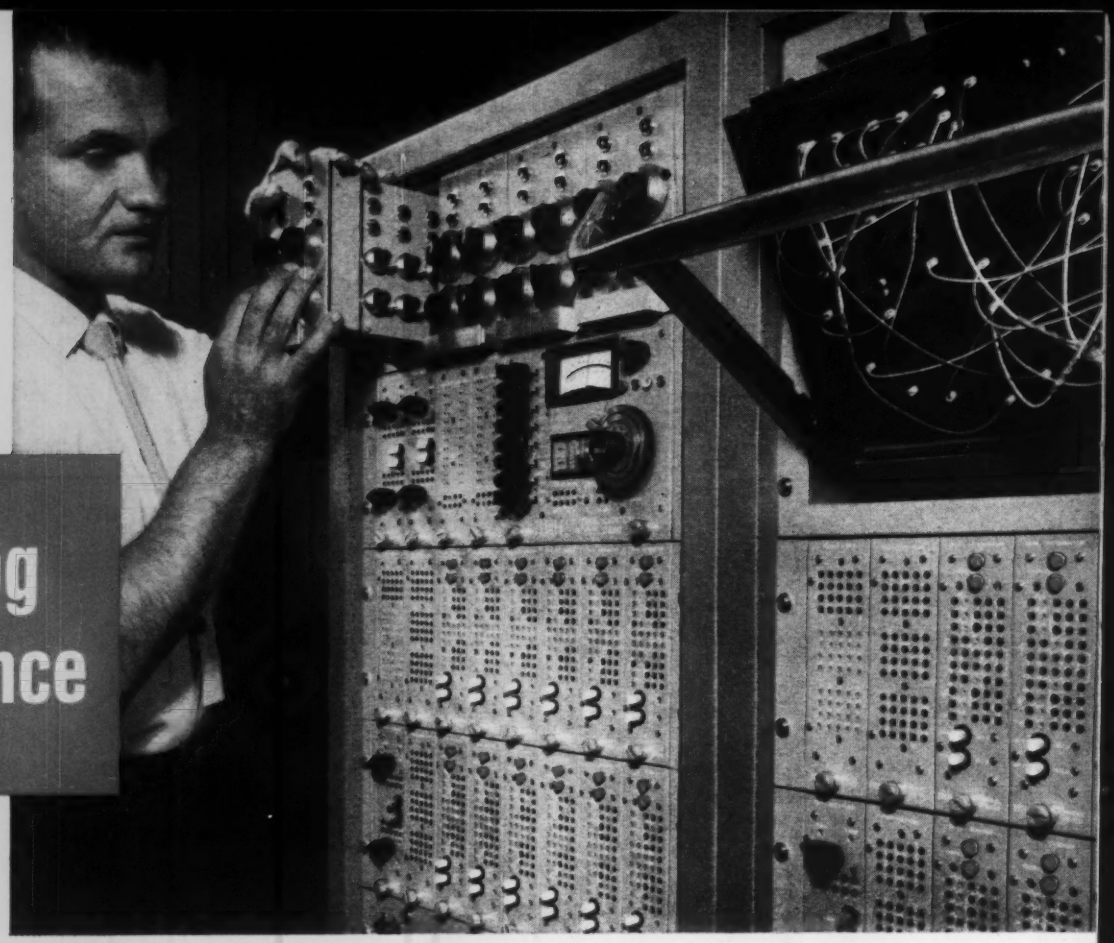
$$\Delta t_2 = \frac{2K_2}{M(K_2 - K_1)}$$

$$T = \Delta t_1 + \Delta t_2 = \frac{4}{M}\left[\frac{1}{1 - \left(\frac{K_1}{K_2}\right)^2}\right]$$

$$M = \frac{4}{T}\left[\frac{1}{1 - \left(\frac{K_1}{K_2}\right)^2}\right]$$

$$K_1 = \left[\frac{\Delta t_2 - \Delta t_1}{\Delta t_2 + \Delta t_1}\right] K_2$$

Since Amplifier 2 changes polarity with $-(e_1 + e_o)$, there are two distinct cases with which to deal.



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- **NEW AMPLIFIER** Bandwidth, 1 mc; drift, 20 microvolts per day; gain, 10^8; noise, 500 microvolts; output, ± 100 volts @ 20 milliamps. Three types of dual amplifiers are available — integrators, summers and inverters.

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Forward and reverse relay logic is incorporated for either iterative or continuous operation.

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DONNER SCIENTIFIC DIVISION

SYSTRON-DONNER Corporation

CONCORD, CALIFORNIA

Case I:

$$e_o = K_2$$

Initially

$$e_1 = K_2$$

During the first increment of time

$$e_1 = K_2 - M(K_2 + K_1)\,t_1$$

At the switching point:

$$e_1 + e_o = 2K_2 - M(K_2 + K_1)\,\Delta t_1 \approx 0$$

or

$$\Delta t_1 \approx \frac{2K_2}{M(K_2 + K_1)}$$

Case II:

$$e_o = -K_2$$

At the end of Δt_1 seconds

$$e_1 = -K_2$$

During the second increment of time

$$e_1 = -K_2 + M(K_2 - K_1)\,\Delta t_2$$

The switching occurs when

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$$\frac{K_1}{K_2} = \frac{\Delta t_2 - \Delta t_1}{\Delta t_2 + \Delta t_1} = \frac{\Delta t_2 - \Delta t_1}{T}$$

$$M = \frac{4}{T}\left[\frac{1}{1 - \left(\frac{K_1}{K_2}\right)^2}\right]$$

Since this circuit is extremely sensitive to the difference $K_2 - K_1$, the diode bridge limiter is necessary to prevent "creep," which is caused by the softness of the shunt limiter. These circuits have been used quite successfully, and experimentation has shown that frequencies up to 60 cps may be obtained without difficulty.

The output of this circuit can be both amplitude and frequency modulated, as can be seen from the following relationships.

Amplitude Modulation

Amplitude $= A = 2K_2$. If the period is a constant, then

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Thus, if both K_2 and K_1 are multiplied by the same factor, the period is unaffected while the amplitude is changed by the multiplicative factor.

Frequency Modulation

$$\text{Frequency} = f = \frac{1}{T}$$

$$= \frac{M}{4}\left[1 - \left(\frac{K_1}{K_2}\right)^2\right]$$

Hence the frequency alone will be affected if M is altered.

Pulse Width Modulation (Fixed Period)

A third possibility exists in that the relative duration of the positive and negative periods can be regulated. Thus, the ratio of the duration of the positive pulse to the total period is

$$\Delta t_1 = \left[\frac{2K_2}{M(K_2 + K_1)}\right]\frac{M}{4}\left[1 - \left(\frac{K_1}{K_2}\right)^2\right]$$

$$= \left[\frac{K_2}{2(K_2 + K_1)}\right]\left[\frac{K_2^2 - K_1^2}{K_2^2}\right]$$

$$= \left(\frac{1}{2}\right)\left(\frac{K_2 - K_1}{K_2}\right) = \left(\frac{1}{2}\right)\left(1 - \frac{K_1}{K_2}\right)$$

hence

$$K_1 = \left(1 - \frac{2\Delta t_1}{T}\right)K_2$$

will produce the desired $\frac{\Delta t_1}{T}$ ratio.

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We see by a 12-page news release that some big names in the East have finally taken to heart what we have been preaching in these columns for the past nine years. This is that **Simulation** is a powerful tool for the study of complex systems involving the interaction of components, including people, which cannot be described in exact mathematical terms.

These people, who are marketing their considerable talents under the name "Simulmatics"* are, as may be expected, simulating the hard way; they are using digital computers.

This observer might be expected to predict that in another nine years, experience will have taught the founders of Simulmatics that for many kinds of simulation the analog computer is a far better tool than the digital. Certainly this is true when empirical studies require "dial twiddling," and it is true for those studies where it is desirable to preserve something like a one-to-one correspondence between computer and real-life components, thus to gain an insight into the dynamics involved. And the analog is certainly the better computer where it is important to observe the interplay of factors while a solution is being sought rather than in retrospect.

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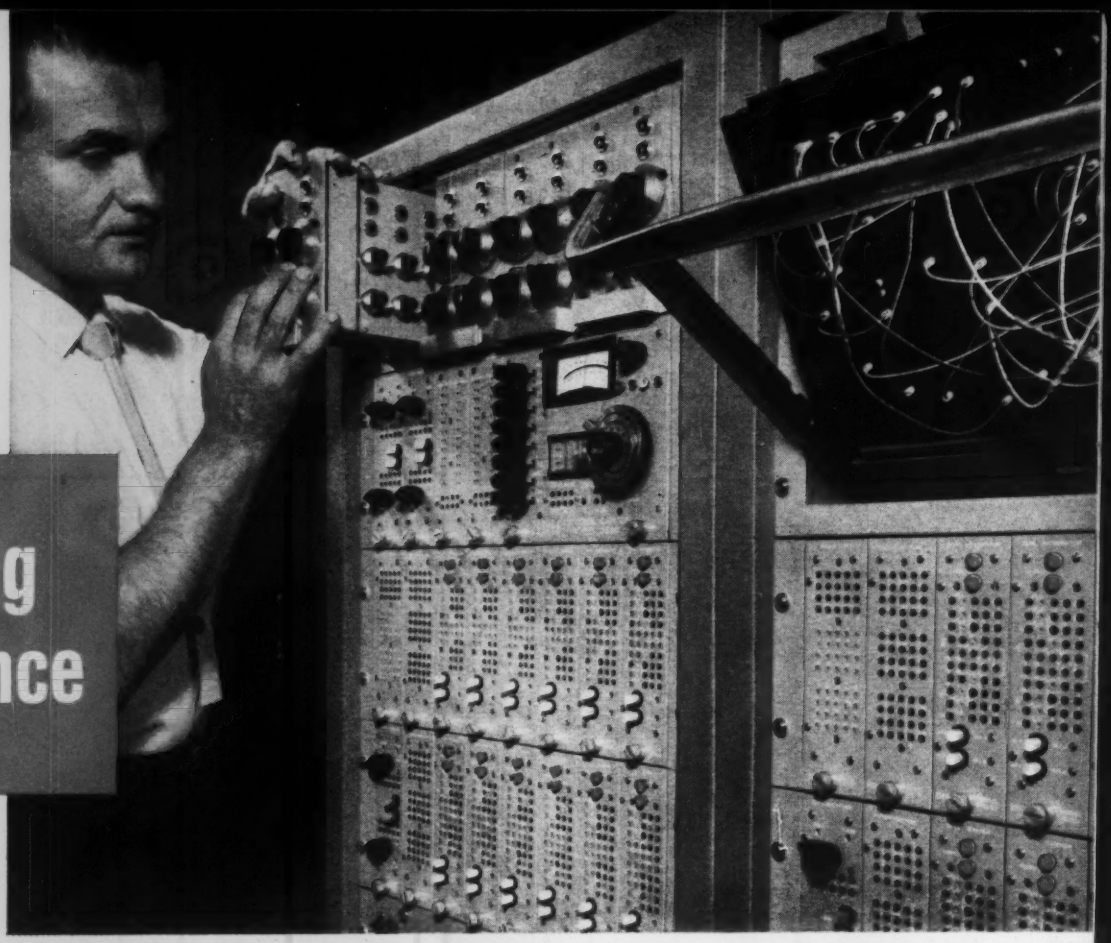
← CIRCLE 83 ON READER-SERVICE CARD



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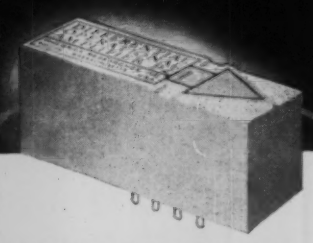

NO TUBES, NO CHOPPERS, NOTHING BUT PERFORMANCE. An ingenious arrangement of all solid-state components endows this operational amplifier with the most remarkable and versatile characteristics. *Full differential input:* truly floating with respect to ground. *No common mode error. Low input current:* typically 10^{-11} amps. *Low noise:* typically under 10 microvolts in the dc to 1 kc range. *Sub millivolt long term stability:* less than 100 microvolts drift per day. *Cool running:* typically under 330 milliwatt dissipation. *Wide band pass:* typically under 75 kc as a unity gain follower. *High open loop gain:* typically 30,000. Its output delivers 1 ma at ± 10 volts. The cast aluminum housing fits right in your hand.

Use the P2 for instrumentation, analog computation, and other applications requiring high reliability and accuracy. Take advantage of its differential inputs to perform high impedance operations. *Truly low cost:* **$210.**

SOLID STATE POWER SUPPLY PR 150. For energizing at least 10 P2 amplifiers, the PR 150 has extremely low noise, drift, and internal impedance. Regulation against load, less than 300 microvolts. It provides up to 150 ma at both plus and minus 15 volts. Price: **$285.**

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action can be simulated literally in minutes. Hypothetical history can be played out. Events can be posed and their effect on the course of the future can be determined.

"Moreover, simulation does not make the mistake of assuming that a single set of circumstances produces only one possible outcome in human affairs.

"By repeating the simulation process many times, a range of outcomes is produced. Each is dependent upon the fact of free choice in human behavior. The distribution of outcomes permits assessing the most probable future and its range of possible variations."

He Went Thataway!

Lad Kovach, who—in addition to being chairman of the Steering Committee of the Western Simulation Council—is Professor of Mathematics and Acting Head of the Department of Mathematics and Physics at Papperdine College, has received a part-time appointment as visiting professor at the University of California at Los Angeles, where he will work with the Curriculum Study Committee in the Department of Engineering.

Letters

Dear Editor:

I should like, with your kind permission, to take this opportunity to express some personal views of mine concerning ethical behavior of members of Simulation Councils, Inc.

1. I think that during the election proceedings in the various local councils a member of Simulation Councils, Inc. should not nominate for office any person who is employed by the same employer (in the case of Government employees, the implication is two people working in the same facility). This sort of activity has taken place many times in the past, and on several occasions has resulted in the election of extremely competent and worthy people. However, I feel that these people would most likely have been nominated by others and elected in any case, and on the other side of the coin, many such nominations have been unsuccessful and have, if anything, embarrassed the person nominated.
2. I think that the Chairman of the Steering Committee of the regional council should maintain complete technical control over the regional council meetings. At various times and places in the past, some host organizations have completely dominated meetings held in their facilities. There have been occasions where this has been necessary because of the type of facility visited and the type of program planned that day. This is all to the good. But there have been other occasions where the host organization has taken advantage of the opportunity to make the meeting one long and thinly disguised commercial for his organization.
3. I think that vendors of analog-computing equipment should be extremely careful not to give the impression that they are using their positions and presence in Simulation Councils, Inc. for the direct commercial advantage of their company. Some of our most active and effective officials have been vendors. To these people I wish to extend my sincere thanks for their efforts and hope that they will continue to serve in these capacities. However, there have been instances where a few people have used their positions unwisely. There have been instances where some vendors have tried to exploit the fact of their participation in Simulation Council meetings with blatant commercial tactics. I always welcome a good, sound technical discussion—especially one which brings forth new techniques or discloses new hardware or indicates an area of future interest—but I decry the efforts of some who, when a competitor does attempt to make a contribution to the state of the art, merely yell in a loud voice "I can do it too, only a little better."

I want to emphasize that the above thoughts are strictly my own and do not necessarily reflect the views of other members of the Board of Directors nor of the Editor of the *Newsletter*. I welcome discussion of these views by other members of Simulation Councils, Inc. and also urge you to submit any similar thoughts which you may have on these or other subjects in the general area of ethics.

J. E. Sherman, Chairman
Board of Directors

SCI Activities

Western Simulation Council meeting on "The Future of Analog Computation," Hotel Ambassador, Los Angeles, California, 12 May 1961. In spite of tape recorder failure, *F. C. Rieman* and colleagues of Space Technology Laboratories were able to put together some interesting notes on this meeting, which we will edit and publish next month.

Milt Aronson, editor of the front and back covers of this *Newsletter*, has also edited and sent to us one of the papers, "Simulation of Continuous Slab Heating Furnaces" by *A. H. El-Waziri*, presented at the July 10th meeting of the Midwestern Simulation Council at the U. S. Steel Company plant at Monroeville, Pennsylvania. This, with any other info we get on the meeting, will be reported in the near future.

We have also received announcements of the following meetings:

Western Simulation Council, Autonetics-La Palma, Anaheim, California; 14 September 1961. Papers presented were:

"The Use of Computers in Armament and Flight Control System Analysis" by *H. L. Ehlers*; "Autonetics Simulation Facilities" by *R. D. Blosser;* "Combined Analog-Digital Simulation in Analysis of Minuteman Control System" by *J. M. Johnson;* "Human Factors Display and Simulation" by *A. C. Poff* and *R. G. Kinkade.*

Midwestern and Central Simulation Councils, joint meeting on "Generation of Functions of One or More Variables by Analog and Digital Methods," at Central Research Laboratory of Minnesota Mining and Manufacturing Company, St. Paul, Minnesota, on 18 September 1961. Papers presented:

"A Photoformer Function Generator for Two Independent Variables" by *L. G. Polimerou*; "Function Generation Using Pot-Padders" by *L. H. Fricke*; "Using a Digital Computer as a Function Generator for an Analog Computer" by *Otto Reichardt;* "Function Generation Using Standard Analog Elements" by *F. J. Sansom.*

ANALOG APPLICATIONS ENGINEERS

The Orlando, Florida, Division of The Martin Company has immediate openings for analog applications engineers. While experience and/or an advanced degree is preferred, engineers with BSEE and a strong interest in analog applications will receive definite consideration.

Work will include study of missile system and simulation problems, and the formulation of advanced proposals. Our engineers work with one of the largest automatically programmed systems in the country.

Send your resume to Mr. C. H. Lang, Sec 101, The Martin Company, Orlando, Florida.

MARTIN
ORLANDO

All qualified applicants will be considered for employment without regard to race, creed, color, or national origin.

CIRCLE 85 ON READER-SERVICE CARD

NEW! PRE-PROGRAMMING AND PROBLEM STORAGE IN A LOW COST, DESK TOP ANALOG COMPUTER

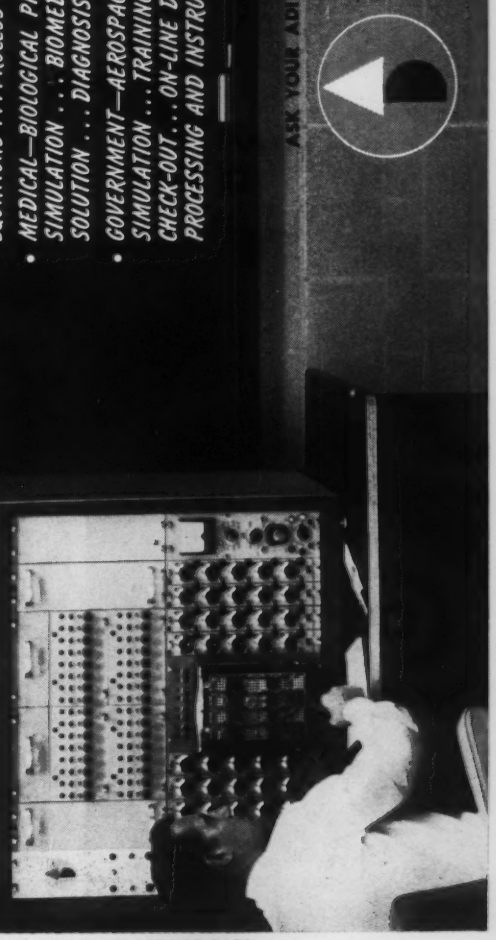
NOW... CONSOLE COMPUTER ADVANTAGES AT DESK TOP COST... WITH THE NEW ADI-1-32PB... COMPLETE WITH REMOVABLE, COLOR-CODED PRE-PATCH PANEL.

APPLICATIONS

- EDUCATION—DIFFERENTIAL EQUATION SOLVING... DYNAMIC PHYSICAL SYSTEM SIMULATION... TEACHING AID.
- INDUSTRY—SERVO DESIGN... HEAT TRANSFER PROBLEMS... WAVE EQUATIONS... PROCESS CONTROL.
- MEDICAL—BIOLOGICAL PROCESS SIMULATION... BIOMEDICAL EQUATION SOLUTION... DIAGNOSIS.
- GOVERNMENT—AEROSPACE SYSTEMS SIMULATION... TRAINING... AUTOMATIC CHECK-OUT... ON-LINE DYNAMIC SIGNAL PROCESSING AND INSTRUMENTATION.

FEATURES

- ALL-ELECTRONIC MULTIPLICATION, RE-SOLVING AND REPETITIVE (ITERATIVE) OPERATION.
- ACCURACY TO 0.05%.
- MODERATE COST... PROVEN RELIABILITY.
- OPTIONAL TEMPERATURE CONTROL OF COMPUTING ELEMENTS.
- PLUG-IN STABILIZERS FOR ADDITIONAL ECONOMY.
- PRE-WIRED FOR EASY, "PLUG-IN" FIELD EXPANSION.

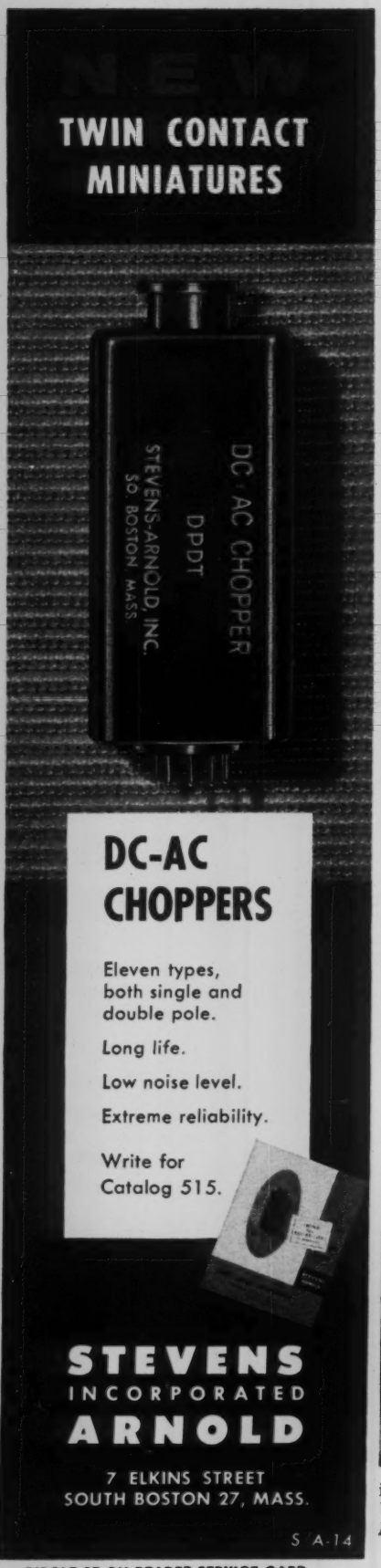


ASK YOUR ADI REPRESENTATIVE FOR DETAILS, OR WRITE DIRECT

Applied Dynamics, Inc.

3775 PLATT ROAD, ANN ARBOR, MICHIGAN • AREA CODE 313 • PHONE 665-4693

CIRCLE 86 ON READER-SERVICE CARD



CIRCLE 87 ON READER-SERVICE CARD

ICS NEW INSTRUMENTS

FIBER OPTICS CRT

New fiber-optics Cathode Ray Tubes print recording directly from tube face without use of conventional lenses, up to 50 times faster. Available with electrostatic deflection and focus for experimenters, and electromagnetic deflection and focus for small spot size to full utilize high resolution. Both tubes have active fiber optics area of 2¾" x ¼" composed of 1-mil fibers on 1-mil centers. —*American Optical Co., Southbridge, Mass.*

CIRCLE 239 ON READER-SERVICE CARD

PRINTER CONTROL UNIT

New Control Pedestal for Series 4-1000 High Speed Line Printer houses all electrical and electronic components including solid-state hammer drive circuitry, power supplies, and power sequencing units. Buffering and logic also can be included. Operates on single-phase 115v ± 10%, 60-cycle or three-phase 208v ± 15%, 60-cycle power.—*Anelex Corp.*, 150 *Causeway St., Boston* 14, *Mass.*

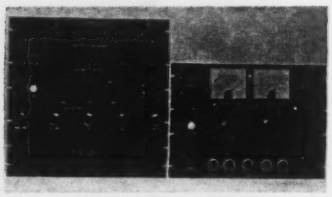
CIRCLE 240 ON READER-SERVICE CARD

MISSILE FUEL VALVE

New self-draining Model 1900 Control Valve is for high-energy exotic rocket fuel lines and for liquid manufacturing plants. Screwed or flanged connections; bodies of carbon steel, stainless type 304, 316 and 347, Hastelloy "B" and "C", Monel. Operation by pneumatic Domotor, electropneumatic or electrohydraulic cylinder, or handwheel.—*Annin Co., Div. Worthington Corp.*, 1040 *S. Vail Ave., Montebello, Calif.*

CIRCLE 241 ON READER-SERVICE CARD

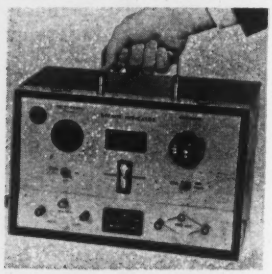
CAPACITOR TESTER



New automatic Capacitor Tester Model 8515 sequentially measures leakage current in as many as 50 capacitors and records failures. Panel lights indicate unit under test. Also, Model 8514 Automatic Hypot supplies d-c potential continuously adjustable from 0 to 20 kv for capacitor testing. Motorized control raises test potential at rate of 300 v/sec to any pre-set value, then returns to zero. Leakage current measurement ranges are 0-10 and 0-250 μamp.—*Associated Research, Inc.*, 3777 *W. Belmont Ave., Chicago* 18, *Ill.*

CIRCLE 242 ON READER-SERVICE CARD

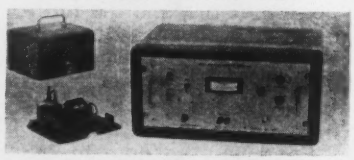
PORTABLE STRAIN INDICATOR



New portable Strain Indicator Type 20 with digital readout has gage factor range increased to 1.50 through 4.50. Strains are read directly as sum of digital counter indication and "add-to-reading" setting. Accuracy on counter is 0.1% of reading.—*Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div.*, 42 *Fourth Ave., Waltham* 54, *Mass.*

CIRCLE 243 ON READER-SERVICE CARD

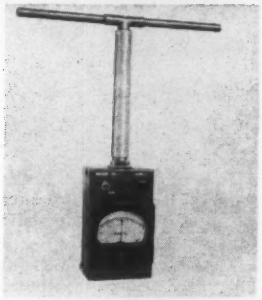
INFRARED TEST SET



New Model 16-110 Infrared Radiation Test Set radiometric measuring system tests or evaluates optical systems, detectors, or detector electronics. Basic set consists of motor-chopper assembly, detector-preamplifier assembly, and synchronous rectifier amplifier.—*Barnes Engineering Co.*, 30 *Commerce Rd., Stamford, Conn.*

CIRCLE 244 ON READER-SERVICE CARD

MAGNETIC FIELD DETECTOR



New sensitive Model 501 Detector measures d-c magnetic fields as low as one-quarter gauss, is based on Hall-effect, utilizes high-gain Siemens Hall generators without amplifiers; has only one mercury cell.—*Halltest Div., Instrument Systems Corp.*, 129-07 18*th Ave., College Point, N. Y.*

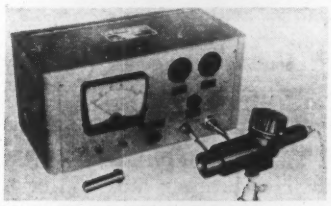
CIRCLE 245 ON READER-SERVICE CARD

SPARK GAP

New ceramic-metal, triggered Spark Gap GP-15 with 70-kv hold-off voltage handles peak currents greater than 10,000 amp. Triggering is by 25-kv min pulse; delay time is 0.5 μsec at 80% of maximum hold-off voltage. No filament power required.—*Edgerton, Germeshausen & Grier, Inc.*, 160 *Brookline Ave., Boston* 15, *Mass.*

CIRCLE 246 ON READER-SERVICE CARD

RADIATION PYROMETER



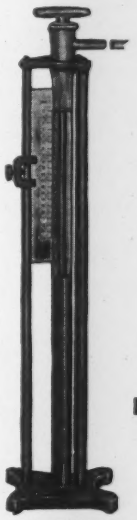
New Model PY45 Pyrotel non-contacting infrared Radiation Pyrometer-Controller incorporates synchronous chopper for stability, sensitivity, and rapid response times of 20 msec, affording temperature readings on 0.0003"-dia wire travelling at 5000 ft/min. Features built-in relay to provide warning signals for manual adjustment or for automatic step control of heaters.—*Mason Instrument Co., Inc., Dept.* 45, 222 *Valley Pl., Mamaroneck, N. Y.*

CIRCLE 247 ON READER-SERVICE CARD

Sensitive · Compact · Practical

DUBROVIN VACUUM GAUGES

Far More Sensitive Than Mercury Manometer



No. 1451 C. Table Mounting

Made expressly by WELCH For Moderately Reduced Pressures

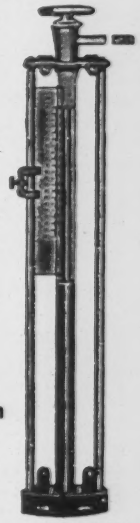
Range: 0.2 mm To 20 mm of Hg

•

Two Sensitivities Available

•

Pyrex-Brand or Soft-Glass Construction



No. 1451 H. Wall Mounting

EASY TO INSTALL - CONVENIENT TO USE

The Welch-Dubrovin Gauges are made in two basic types. One 9 times and the other 6 times as sensitive as a mercury manometer. Because of this "magnifying factor," the gauge is as sensitive as a manometer which uses a liquid of low density, but has the advantage of using mercury which dissolves very few organic or inorganic vapors and which requires no conversion factor. Unlike mechanical or optical magnifying devices, any small errors due to capillarity, adhesion, etc., are not magnified. The smallest division on the 9-to-1 type is 0.2 mm and on the 6-to-1 type is 0.5 mm of Hg. Fractions of these values may be estimated. Both types are available with Pyrex-brand or soft glass in either table or wall mounting.

PRICED AT $47.50 AND $55.00

THE WELCH SCIENTIFIC COMPANY

ESTABLISHED 1880

1515 Sedgwick Street, Dept. B, Chicago 10, Illinois, U.S.A.

Manufacturers of Scientific Instruments and Laboratory Apparatus

CIRCLE 88 ON READER-SERVICE CARD

DIVIDER-COMBINER VALVE

New Model 1467 Flow Divider-Combiner Valve divides pump output (up to 40 gpm) into two equal flows for simultaneous operation of two cylinders, or equalizes return flows of two cylinders to equalize piston speeds. Bulletin FF 20.—*Waterman Hydraulics Corp.*, 725 *Custer Ave., Evanston, Ill.*

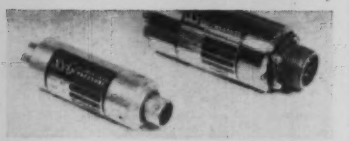
CIRCLE 248 ON READER-SERVICE CARD

MULTIPLEX STEREO

New Model 830 Multiplex Stero Generator operates with F-M signal generator, audio oscillator, and oscilloscope to provide composite stereo signal in conformance with recent FCC multiplex decision, Docket 13506. —*H. H. Scott, Inc., Instrument Div.*, 111 *Powdermill Rd., Maynard, Mass.*

CIRCLE 249 ON READER-SERVICE CARD

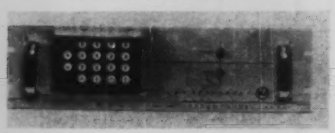
PRESSURE TRANSDUCERS



Two new silicon-semiconductor strain-gage Pressure Transducers for absolute and gage pressures have sensing elements of piezo-resistive semiconductor materials: Model 3S-G low-pressure absolute transducer is made airborne or ruggedized. Pressure ranges: 0-10 to 0-100 psia for both models.—*Fairchild Controls Corp., 219 Park Ave., Hicksville, L. I., N. Y.*

CIRCLE 250 ON READER-SERVICE CARD

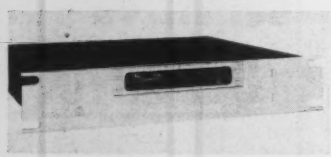
A/D CONVERTER



New transistorized analog-to-digital Converter Model 5000 makes 15,000 complete voltage readings/sec, has overall accuracy of ±0.01% + 1 digit, features true bi-polar operation. Model 5000B provides output in straight binary. Both Models have digital readouts.—*Non-Linear Systems, Inc., Box 728, Del Mar, Calif.*

CIRCLE 251 ON READER-SERVICE CARD

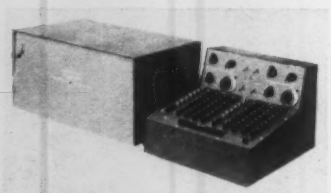
LAB BRIDGES



New laboratory-standard Bridges permit checking synchros or resolvers to 20-ppm accuracy. Provide measurements in 5° steps 0-360°. Absolute accuracy 0-800 cps is 0.002%. Frequency range extends to 10 kc at reduced accuracy.—*Julie Research Labs., Inc., 603 W. 130th St., New York 27, N. Y.*

CIRCLE 252 ON READER-SERVICE CARD

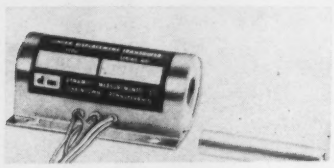
MACHINE PLOTTING



New Model 110 Log-Lin Keyboard permits rapid and efficient plotting of numerical data on either log or linear paper. Consists of keyboard and converter unit. Bulletin.—*King Scientific Co., 316 Bucknell Rd., Costa Mesa, Calif.*

CIRCLE 253 ON READER-SERVICE CARD

DISPLACEMENT TRANSDUCERS

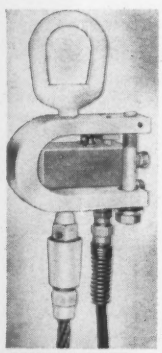


New line of universal Linear Displacement Transducers operate on differential transformer principle. Input voltages 12 to 115 v; input impedances 150 to 5500 ohms; outputs 10 to 35 v. Units have minimum phase shift, low null, high linearity.—*Dynamic Measurements Co., Terwood Rd., Willow Grove, Pa.*

CIRCLE 254 ON READER-SERVICE CARD

OVERLOAD SWITCH

New Dyna-Switch immediately stops motor when crane or hoist attempts to lift loads beyond preset limits. New cable socket feature permits installation in tight quarters. Safety factor rating is far in excess of strength of cable.—*W. C. Dillon & Co., Inc., 14620 Keswick St. Van Nuys, Calif.*



CIRCLE 255 ON READER-SERVICE CARD

NEW

CHECK VALVES STOP DANGEROUS REVERSE FLOW OF GASES ...HERE

HARRIS

Argon, helium, nitrogen, hydrogen, oxygen . . . Harris Reverse Flow Check Valves work with *all* commercial gases . . . *prevent* contamination of gases in regulators . . . *prevent* accidental mixing of combustible gases with oxygen to eliminate potential explosions . . . *prevent* reverse flow when mixing gases . . . *prevent* suck back on exhausted cylinders (important when using high purity gases).

These new Check Valves have a very low cracking pressure (5 oz.), yet respond instantaneously to reverse flow for positive shut-off. They replace the outlet nipple and are available with all Harris line and cylinder regulators!

For more information, write or call today.

Ask about Harris' laboratory line and cylinder regulators, including the new XX-87 that delivers 0 to 2500 lbs.

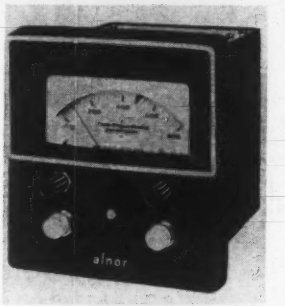
2532-HC

Building World-wide Customer Confidence with Advanced Design Apparatus

THE HARRIS CALORIFIC COMPANY • 5501 CASS AVENUE • CLEVELAND 2, OHIO

CIRCLE 89 ON READER-SERVICE CARD

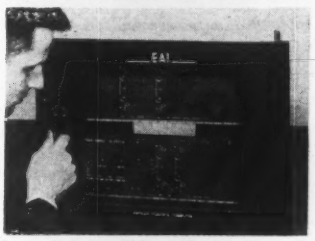
TEMPERATURE CONTROLLER



New time-proportioning Temperature Controller for plastic molding and heat sealing machines, heated dies, etc. incorporates new safety feature that prevents starting machine before material is up to operating temp or shuts down machine if heating element fails to maintain correct operating temperature. Unit accurately proportions heat supply and maintains optimum temperature at all times..—*Alnor Instrument Co.*, 420 *N. LaSalle St., Chicago* 10, *Ill.*

CIRCLE 256 ON READER-SERVICE CARD

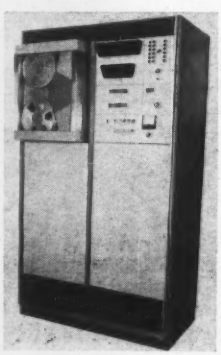
PROCESS CONTROL COMPUTERS



New PC-12 line of Analog Computers for process control is assembled from stock, solid-state modular designed components. PC-12 computers simultaneously and instantaneously accept several inputs and compute several outputs based on complex mathematical relationships, can be used in closed loop control or as advisory devices for operator guidance.—*Electronic Associates, Inc., Long Branch, N. J.*

CIRCLE 257 ON READER-SERVICE CARD

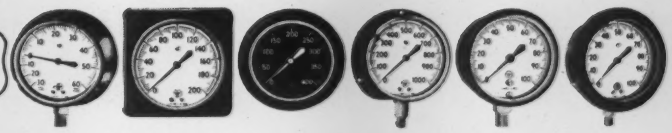
DATA LOGGER

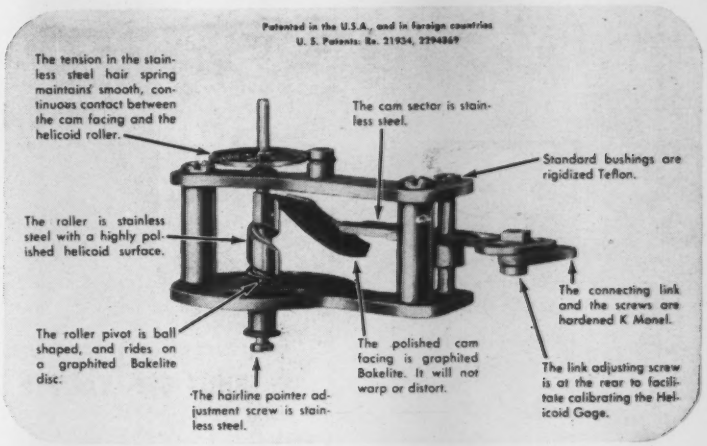


New high-speed Data Logging System accepts up to 16 analog data inputs, multiplexes and converts them into digital values, and records data on magnetic tape in exact computer format. Over-all accuracy is 0.1%. —*Epsco, Inc., System Div., 275 Massachusetts Ave., Cambridge, Mass.*

CIRCLE 258 ON READER-SERVICE CARD

ACCO Helicoid Gage U.S.A.




Patented in the U.S.A., and in foreign countries
U. S. Patents: Re. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is stainless steel.
Standard bushings are rigidized Teflon.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

Exclusive Helicoid movement provides... *Sustained Accuracy... on the toughest jobs*

• Helicoid Gages have no gears, no teeth, reducing wear to an absolute minimum. No danger of fouling, either—rolling action of cam facing keeps contact surface clean. Helicoid Gages have been tested through 75,000,000 cycles, with virtually no wear or loss of accuracy, while conventional geared gages became useless after 500,000 cycles.

Helicoid Gages give *sustained* accuracy even when subjected to violent pressure pulsations or mechanical vibrations. Pointer can be set externally, without removing glass, and cannot be jarred out of position. Dial faces are easy to read, won't corrode or chip. A full range of Helicoid Gages is available for any application. Next time, specify Helicoid—the gage that *stays* accurate.

Bourdon Tubes won't Stretch, Leak, or Crack

Helicoid Bourdon tubes are made from seamless tubing, and are designed for maximum torque and minimum stress. At the factory, each tube is individually tested, overpressured, and stress relieved. Four materials—alloy steel, K Monel, stainless steel, and phosphor bronze—are available to meet applications ranging from tap water to almost any acid.

NEW! Solid-Front Safety Case Gives Added Protection

The new Helicoid solid-front case diverts the force of a burst in a backward direction, away from the operator. The force escapes by deforming, though not detaching, the back cover plate. Helicoid Gages are also available in phenol, acaloy flanged, acaloy flangeless, polished flangeless, round flush, polished flush ring, and square flush cases.

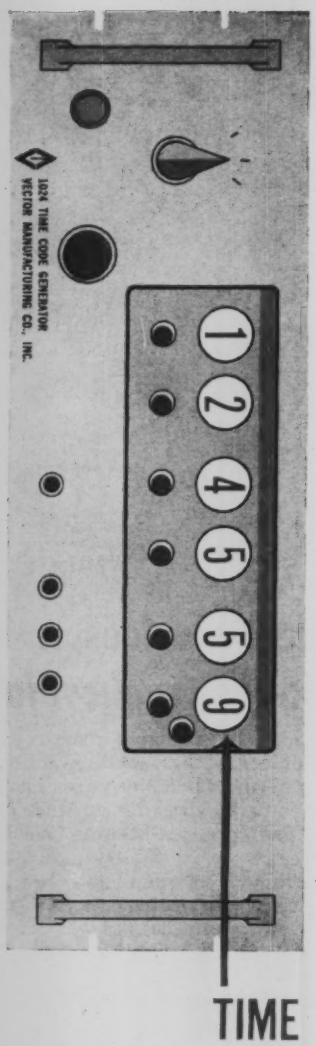
WRITE for details **Ask for Catalog DH-65**

HELICOID GAGES

Helicoid Gage Division • American Chain & Cable Company, Inc.

929-B Connecticut Ave., Bridgeport 2, Conn.

CIRCLE 90 ON READER-SERVICE CARD



VECTOR 1024 TIME CODE GENERATOR provides pulse code for digital measurements of clock time. Output jackplug allows entry of Real Time into digital systems or computers.

Operates in combination modes. Continuous visible display with jackplug output in hours, minutes and seconds, or in electrical or mechanical full seconds.

Switch controlled for six magnetic tape speeds. Real Time channel displayed on oscillograph or tape in six-digit sequential Binary Coded Decimal frequency.

Transistorized solid-state circuitry. Rack or bench models available.

Write for further information.

VECTOR MANUFACTURING CO., INC.
Commercial and Industrial Division
Southampton, Pennsylvania

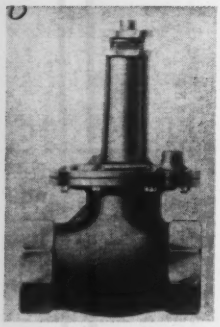
CIRCLE 91 ON READER-SERVICE CARD

FLOW ALARM

New Fig. 1885-CDA FLO-EYE Flow Indicator with integrally mounted adjustable alarm has plug rising and falling with changes in flow rate. Operating read-type alarm switch adjusts in range of 0.05 to 10 gpm.—*Schutte and Koerting Co., Instrument Div., Cornwells Heights, Bucks Co., Pa.*

CIRCLE 259 ON READER-SERVICE CARD

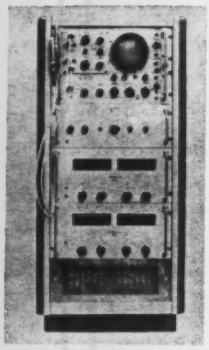
SHUT-OFF VALVES



New IP-L/TEMP line of Automatic Shut-off Valves providing dual automatic safety by closing on either increasing pressure and ambient temperature or both incorporates diaphragm which senses line pressure and programs valve into "close" position whenever line pressure exceeds pre-determined level. In addition, fusible plug with pre-determined temperature setting is activated when ambinent thermal point is reached.—*Security Valve Co.*, 909 *El Centro Ave., South Pasadena, Calif.*

CIRCLE 260 ON READER-SERVICE CARD

WAVE FORM MEASURING



New DY-5844 Automatic Waveform Measuring System measures time intervals between any two points chosen from 0-100% level of either stimulus or response pulse. Accuracy is better than ±4% of full scale, ±0.4 nanoseconds. System features dual inputs to measure stimulus and response pulses simultaneously; oscilloscope monitoring of both pulses simultaneously; and high speed, with selected parameters measured in ¼ sec. —*Dymec Div., Hewlett-Packard Co., Palo Alto, Calif.*

CIRCLE 261 ON READER-SERVICE CARD

Increased technical responsibilities in the field of range measurements have required the creation of new positions at the Lincoln Laboratory. We invite inquiries from senior members of the scientific community interested in participating with us in solving problems of the greatest urgency in the defense of the nation.

RADIO PHYSICS and ASTRONOMY

RE-ENTRY PHYSICS

PENETRATION AIDS DEVELOPMENT

TARGET IDENTIFICATION RESEARCH

SYSTEMS:
- Space Surveillance
- Strategic Communications
- Integrated Data Networks

NEW RADAR TECHNIQUES

SYSTEM ANALYSIS

COMMUNICATIONS:
- Techniques
- Psychology
- Theory

INFORMATION PROCESSING

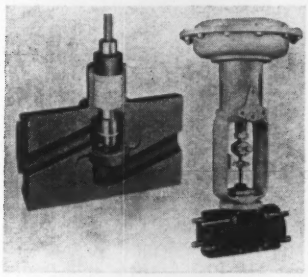
SOLID STATE
- Physics, Chemistry, and Metallurgy

• *A more complete description of the Laboratory's work will be sent to you upon request.*

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

Research and Development
LINCOLN LABORATORY
Massachusetts Institute of Technology
BOX 35
LEXINGTON 73, MASSACHUSETTS

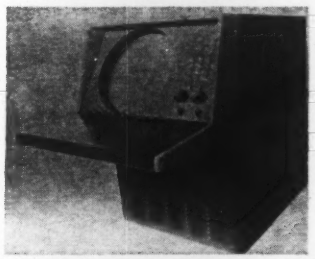
IMPERVIOUS GRAPHITE VALVE



New single-seated Control Valve utilizes impervious graphite in split-body construction. Unaffected by corrosives and immune to effects of thermal shock. Available with quick-opening, equal-percentage, and linear plugs, and Fisher Governor topworks. —*Falls Industries, Inc., Solon Ohio.*

CIRCLE 262 ON READER-SERVICE CARD

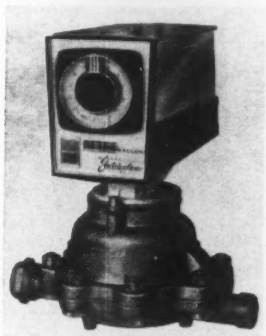
DIRECT VIEW DISPLAY



New Model S-C 1090 Direct-view Display Console for monitoring digital computers provides information display of extremely high resolution and brightness on CHARACTRON® shaped beam tube. Displays well over 1000 characters on tube face.—*General Dynamics/Electronics, Information Technology Div., 1895 Hancock St., San Diego 12, Calif.*

CIRCLE 263 ON READER-SERVICE CARD

POSITIVE DISPLACEMENT METER



New Niagara Electrivolume Meter automatically delivers pre-set quantity of liquid, actuates other Electrivolume Meters from master meter. Can be used to start or stop pumps, to operate solenoid valves, signaling devices, electric relays and other processing equipment.—*Buffalo Meter Co., 2906 Main St., Buffalo 14, N. Y.*

CIRCLE 264 ON READER-SERVICE CARD

MAG
AMPS
MAGNETIC AMPLIFIER
Confidence
in a
quality product
The fast response, wide dynamic range, high gain and light weight of an Airpax MAG AMP provide the systems engineer with that extra degree of versatility which permits a successful design rather than a marginal system.
AIRPAX
ELECTRONICS
INCORPORATED
SEMINOLE DIVISION • FT. LAUDERDALE, FLA.

CIRCLE 92 ON READER-SERVICE CARD

TIME PROPORTIONING TEMPERATURE CONTROLLER with ADDED SAFETY CIRCUIT

Designed for controlling the temperature for all plastic molding and heat sealing machines, heated dies, ovens and cooking vessels.

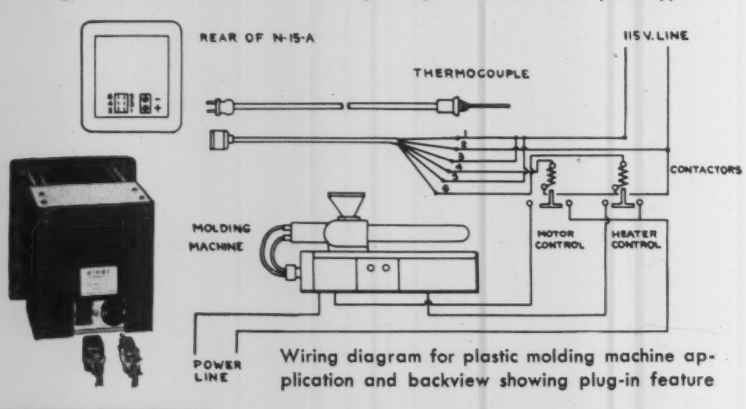
The added safety features of the New Alnor Pyrotroller makes it a distinctive instrument in the temperature control field.

A special circuit prevents starting the production machine before the temperature of the material handled is up to the correct operating temperature. This same circuit will automatically shut down the machine if the heat source fails to keep the material up to the correct operating temperature thus preventing mechanical damage to the machine.

This safety feature is equally valuable on heat sealing machines or cooking vessels to prevent operating at a temperature that would result in a faulty product.

The Pyrotroller operating parts are few in number and of a high order of reliability. Each component is oversize for its required performance to permit operating well below its rated capacity. This engineering philosophy results in a very reliable instrument of long trouble free field life. The extremely rugged construction of the Pyrotroller makes it highly resistant to machine vibration and its unusual accuracy in proportioning the heat supply enables it to maintain the optimum temperature at all times.

Scale ranges 0-400° F to 0-3000° F. ***Engineering service available on special applications***



Wiring diagram for plastic molding machine application and backview showing plug-in feature

Alnor INSTRUMENTS

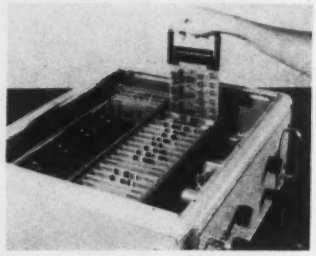
ALNOR INSTRUMENT CO.

Division of **Illinois Testing Laboratories, Inc.**

Room 518, 420 N. LaSalle St., Chicago 10, Illinois

CIRCLE 93 ON READER-SERVICE CARD

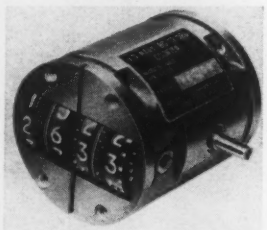
HIGH-SPEED TRANSCEIVER



New HC-270 transistorized digital data Transceiver is for high-speed serial transmission at rates up to 4,800 bits/sec. Information is coded on single tone in form of four orthogonal phases and decoded by element-to-element comparison.—*Hughes Aircraft Co., Communications Div., Box* 90-902, *Los Angeles* 45, *Calif.*

CIRCLE 265 ON READER-SERVICE CARD

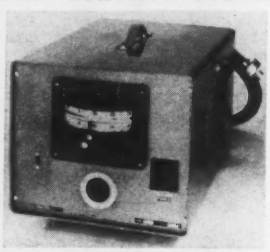
COUNTERS



New Mark II Series Counters, angle units for military and commercial applications, provide continuous displays from 0° to 359.9° for same direction of shaft rotation returning then to 0°; or 0° through 359°. Units are equipped with Geneva drives, have torque levels down to 0.1 in-oz, slew speeds up to 2500 rpm. —*Kearfott Div., General Precision, Inc.*, 1150 *McBride Ave., Little Falls, N. J.*

CIRCLE 266 ON READER-SERVICE CARD

TEMP CONTROL SYSTEM

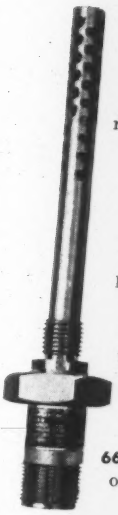


New 30-lb Compact, completely packaged Temperature Control System, provides integrated combination of temperature sensing and power control. Standard units are 4 kva at 117 v and 8 kva at 230 v, available to 33 kva at 230 v. Compact can be used on any furnace or load equal or less than its rated load without concern for matching.—*Loyola Laboratories*, 6415 *W.* 89 *St., Los Angeles* 45, *Calif.*

CIRCLE 267 ON READER-SERVICE CARD

RESISTANCE THERMOMETERS *by* REC.....

−435 to +1800° F



Whether you are concerned with temperature measurements at −435° F or +1800° F there is a wide variety of REC temperature probes to fit your requirements. REC specializes in the design of high precision temperature probes, using highest purity platinum resistance elements.

Care and skill during manufacturing result in strain-free probes of highest stability.

Write for New Catalog No. 66030 for further information on REC's many Temperature Probes, Pressure Transducers, Pitot-Static Tubes.

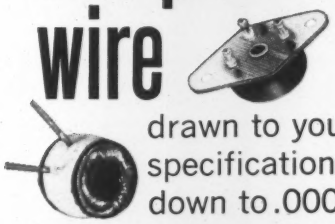
ROSEMOUNT ENGINEERING COMPANY

4900 WEST 78TH ST. MINNEAPOLIS 24, MINNESOTA

CIRCLE 94 ON READER-SERVICE CARD

SECON / engineered

component wire



drawn to your specifications down to .00025" in base and precious metals and alloys

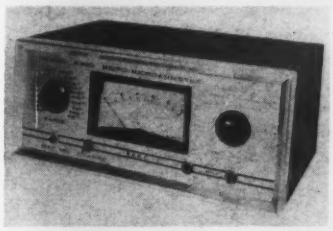
These wires can be supplied bare, enameled, ceramic insulated for use at 1000° F., or electroplated—to close tolerances.

Let our research and development staff solve your wire problems. For more information please write today to Secon Metals Corporation, 7 Intervale Street, White Plains, N. Y. (White Plains 9-4757).

SECON METALS CORPORATION

CIRCLE 95 ON READER-SERVICE CARD

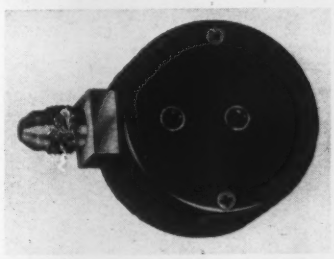
MICRO-MICRO AMMETER



New low-drift (less than ±2% of full scale per week) Micro-micro Ammeter Model R660 has highly-stable, temperature-compensated, transistorized amplifier with electrometer-tube input which produces almost 100% feedback. 20 ranges: 3 x 10^{-8} to 1 x 10^{-12} amp full scale.—*Radiation Technology, Inc., Atlanta, Ga.*

CIRCLE 268 ON READER-SERVICE CARD

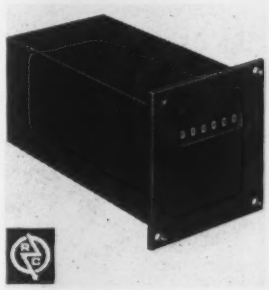
MINI HI PRESS TRANSDUCER



New low-cost Series HPT-10 Transducer providing potentiometric output with very wide pressure range coverage features simple design, temperature of −55°C to +100°C. Full scale range is 0-100 to 0-10,000 psig with a static accuracy band of ±1.5% or better available on most pressure ranges. Resolution is 0.22% to 0.33%. Bulletin HPT-10.—*Instrument Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.*

CIRCLE 269 ON READER-SERVICE CARD

ELECTRONIC IMPULSE COUNTER

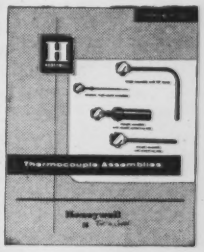


New Electronic Impulse Counter counts 100 impulses per second with a new type electromagnetic stepping motor. Guaranteed life is 500 million counts; is available with either 5 or 6 figure drums and can be operated with electromagnetic or mechanical zero reset.—*Ringsdorff Carbon Corp., Box 22, E. McKeesport, Pa.*

CIRCLE 270 ON READER-SERVICE CARD

THERMOCOUPLE ASSEMBLIES

More than 100 complete T/C assemblies, available in a range wide enough to cover most applications in any industry, under any environmental conditions. Included are straight, angle, high-speed, high-temperature and spring-loaded assemblies. They are among many thousands of accessories—all available from a single dependable source—to help your instruments perform at their best.



Get details from your Honeywell field engineer, or write today for Catalog G100-1.

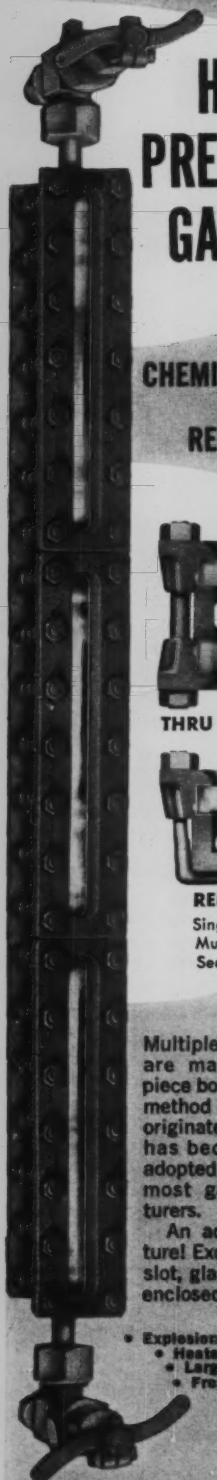
MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

Honeywell

First in Control SINCE 1906

CIRCLE 96 ON READER-SERVICE CARD

Strahman



HIGH PRESSURE GAUGES

FOR CHEMICAL PLANTS AND REFINERIES

THRU VISION

REFLEX
Single or Multiple Sections

Multiple section gauges are made with a one piece body chamber. This method of construction, originated by Strahman, has become generally adopted as standard by most gauge manufacturers.

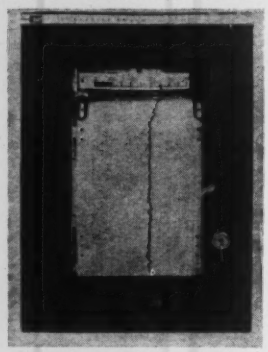
An added safety feature! Except for visibility slot, glass is completely enclosed.

- Explosion proof illuminators
- Heated or cooled gauges
- Large Chamber Gauges
- Frost-proof extensions
- Tubular Gauges
- Gauge Cocks

STRAHMAN VALVES INC.
NICOLET AVE., FLORHAM PARK, N. J.

CIRCLE 97 ON READER-SERVICE CARD

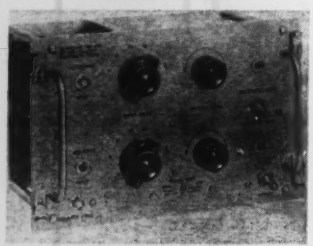
EXPANDED SCALE VOLTMETER



New Expanded Scale Recording Voltmeter features solid-state circuitry, full-scale voltage presentation, mechanical and electrical zeros; uses permanent-magnet moving-coil measuring system. Accuracy is ±1% of full scale value on dc or ac (sine wave); response speed is ½ sec for full recording of voltage change.—*Esterline Angus Instrument Co., Inc., Box 596, Indianapolis 6, Ind.*

CIRCLE 271 ON READER-SERVICE CARD

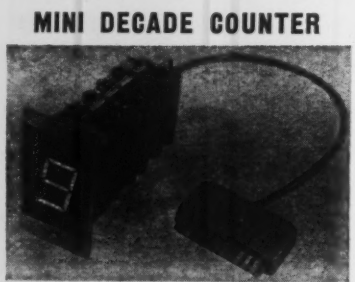
PHASE UNIT



New Model 526D Phase Unit designed as plug-in for Models 524B/C/D electronic counters measures any lead or lag phase angle between two signals in 1-cps-to-20-kc range. Accuracy is $\pm 0.1° \pm (F_p/F_c) \times 360°$, where F_p is frequency of phase-measured signal and F_c is counted frequency—*Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.*

CIRCLE 272 ON READER-SERVICE CARD

MINI DECADE COUNTER



New Model F1601 Miniature Decade Counter with in-plane display operates on 12 v; has modular construction, flexible cable with printed circuit or Amphenol connector, frequency response of 200 kc, less than 5 μsec pulse resolution.—*Robotomics Enterprises, Inc., 4624 E. Garfield, Phoenix 8, Ariz.*

CIRCLE 273 ON READER-SERVICE CARD

Bistable Amplifier for static relay control

Richard B. Doorley, Mgr., New Products Div. Railway Maintenance Corp., Pittsburgh, Pa.

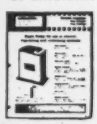
"Norbatrol helped us cut R&D time by 1 year with this Bistable Amplifier"

"Norbatrol's Bistable Amplifiers solved many control problems in redesigning our McWilliams Jack-and-Production Tamper from manual to reliable, automatic operation. Now this RMC railroad surface machine operates electronically—improves grade and cross level to accuracies never previously accomplished. And we got a bonus," Mr. Doorley continues, "these rugged, reliable static relays cost less than alternate systems."

You, too, can speed development and production time with the ultrasensitive Bistable Amplifier—it replaces mechanical relays in critical control and regulating applications. The Bistable incorporates silicon controlled rectifiers, magnetic amplifiers and attendant circuitry to give multiple inputs as low as 5 x 10^{-8} watts, fast response, high gain and a current output of 1 Amp at an 85° C. ambient.

GET THE FACTS on design and application data—write for technical bulletin CS60.

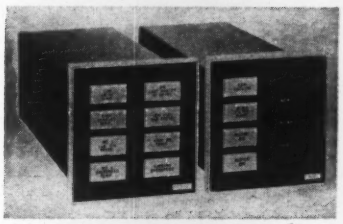
NE-1



NORBATROL Electronics Corp.
DEPT. D 356 Collins Avenue
Pittsburgh 6, Pennsylvania

CIRCLE 98 ON READER-SERVICE CARD

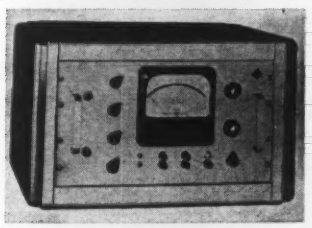
SOLID-STATE ANNUNCIATORS



New solid-state Annunciators include miniature Model 360 plug-in module (shown), "smallest annunciator presently available" (¾" x 1½" x 10"), and Model 361 plug-in modules supplied for conventionally sized (2" x 3") nameplates. Units operate from ac or dc. Bulletin 3060.—*Instrument Div., Thomas A. Edison Industries, McGraw-Edison Co., West Orange, N. J.*

CIRCLE 274 ON READER-SERVICE CARD

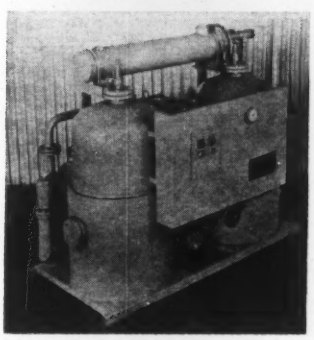
METER CALIBRATOR



Model 600 Meter Calibrator is now provided with calibration data which permits calibration to accuracy of 0.5% for instrument repair work, production floor testing, etc. Unit provides 14 a-c and d-c voltage ranges, 13 d-c current ranges and precision resistance decade.—*Mid-Eastern Electronics, Springfield, N. J.*

CIRCLE 275 ON READER-SERVICE CARD

AIR DRYER



New Type BZ Lectrodryer for compressed air and gases features simplicity, interchangeable parts, few moving parts, automatic operation. Unit works on 6-hr cycle, adsorbs moisture, heats for regeneration and cools; instrumentation permits checking at glance.—*Pittsburgh Lectrodryer Div., McGraw-Edison Co., 32nd St., Pittsburgh 30, Pa.*

CIRCLE 276 ON READER-SERVICE CARD

What does 989°F look like?

One° more than 988. And CEC's Platinum Resistance Temperature Transducer (4-501) knows the difference. Measuring precise temperatures from 0° to 1000°F, it's as new as today's weather. Its special features include all-weld, stainless steel construction, fast response —less than 100 milliseconds, and strain-free ceramic core mount. Need one? Call your CEC office or write for Bulletin CEC 4501-X1.

CEC

Transducer Division

CONSOLIDATED ELECTRODYNAMICS

PASADENA, CALIFORNIA • A SUBSIDIARY OF BELL & HOWELL

CIRCLE 99 ON READER-SERVICE CARD

COLD END LEAD BREAKAGE ELIMINATED

in MgO thermocouples

conax®

T-3 TERMINATION

Optimum MgO thermocouple performance (and ultimate economy) requires that no phase of design or manufacture be overlooked. Conax demonstrates this fact from tip to termination. The T-3 termination's exclusive strain harness design takes all the stresses on the lead wires away from the thermocouple wires. Conax builds in additional value by electrically welding the junctions, thus eliminating corroding and contaminating fluxes that shorten thermocouple life. These are just a few of the facts that make Conax the truly economical thermocouple buy.

TAKE A TIP – GET ALL THE FACTS ON:

Con-O-Clad . . . ask for catalog 300

Thermocouple Assemblies . . . ask for catalog 1890

Electrode Glands . . . ask for catalog 960

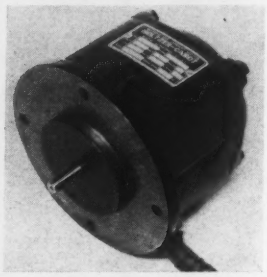
Standard "24 Hour Delivery" thermocouples . . . ask for catalog 2400

conax *CORPORATION*

2305 Walden Avenue • Buffalo 25, New York

CIRCLE 100 ON READER-SERVICE CARD

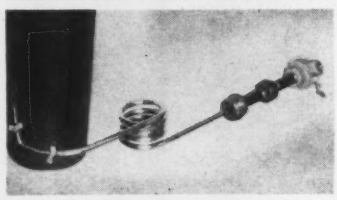
SUB-FHP MOTORS



New line of explosion-proof, subfractional-horsepower Motors is available in 1-, 2-, or 3-phase induction or synchronous types from 1/150 to 1/20 hp; also torque or dynamic brake types. Two-, four-, and eight-pole models give corresponding synchronous speeds of 3600, 1800, and 900 rpm. U/L approved for operation in Class I, Group D and Class II, Groups F and G environments.—*Holtzer-Cabot Motor Div., National Pneumatic Co., Inc.*, 125 *Armory St., Boston* 19, *Mass.*

CIRCLE 277 ON READER-SERVICE CARD

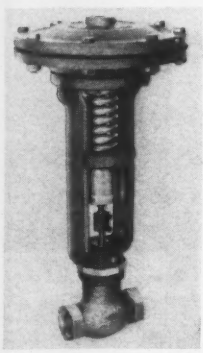
THERMOCOUPLE ASSEMBLY



New Trinox stainless steel Thermocouple Assembly with small pad welded at hot junction for skin temperature sensing is coiled to allow for expansion and contraction of heater tubes. In use, pad and sheath are welded to large diameter heater tubes and accurately transmit temperature measurements.—*Trinity Equipment Corp., Rt.* 281, *Cortland, N. Y.*

CIRCLE 278 ON READER-SERVICE CARD

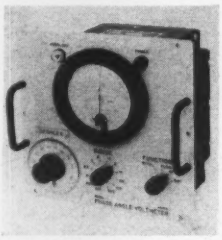
DIAPHRAGM VALVES



New No. 171 Type D Series single-seated, pressure-reducing Diaphragm Valves contain "O"-rings that eliminate use of stuffing boxes, reducing maintenance. Bronze body valves are for working pressures to 300 psi up to 500°F; steel body valves are for 600-psi working pressure. Valves control pressure of steam, fuel oil, water, gas, or air where tight sealing is required. Catalog Sheet 171.—*Atlas Valve Co.*, 280 *South St., Newark* 14, *N. J.*

CIRCLE 279 ON READER-SERVICE CARD

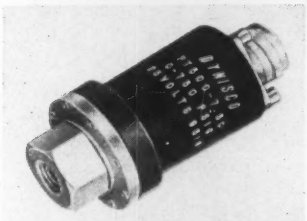
PHASE ANGLE VOLTMETER



New all-transistorized Phase Angle Voltmeter Model VM-235 combines functions of a-c voltmeter, phase meter, phase-sensitive null indicator, and power-factor meter; measures separately in-phase and quardrature components of signal. Features rugged MIL-type, sealed meter, shielded inputs for signal, reference, power and chassis ground, plug-in, and all solid state amplifiers.—*North Atlantic Industries, Inc., Terminal Dr., Plainview, L.I., N. Y.*

CIRCLE 280 ON READER-SERVICE CARD

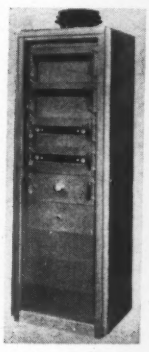
SEMI-CONDUCTOR TRANSDUCER



New PT-500, "first strain-gage transducer to provide high output signal without amplification," is available for gage, absolute, and differential pressure ranges of 0-10, 0-50, 0-250, 0-500 and 0-1,000 psi. Output signal is nominal 5 v at 1000 ohms; transducer withstands up to 50% overload, depending on pressure range; accuracy is within 1% of full scale.—*Dynisco Div. American Brake Shoe Co., 42 Carleton St., Cambridge 42, Mass.*

CIRCLE 281 ON READER-SERVICE CARD

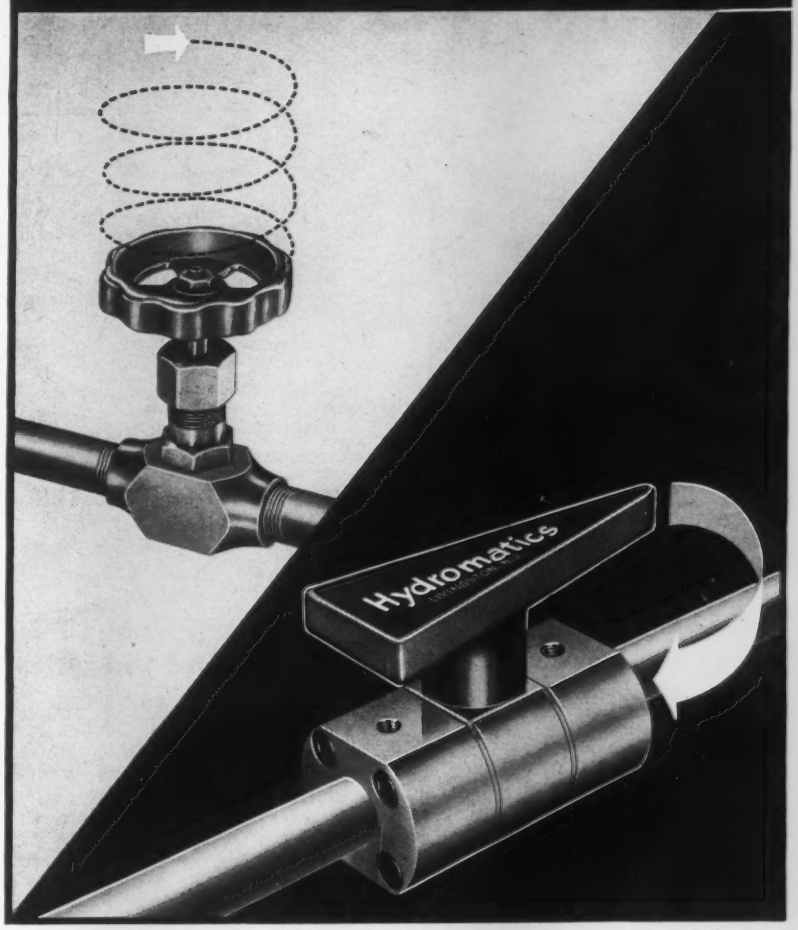
FRINGE MEASURING SYSTEM



New Moire Fringe Measuring System developed for continuous path control of machine tools can be used for evaluation of bubble chamber photographs, film analysis in general, photogrammetry, spectrum analysis, measurement of recorded traces, remote measurement of radioactive specimens, and automatic setting of X-ray and neutron diffractometers. Essential element of system is length of optical diffraction grating having precisely known number of lines per unit length.—*Ferranti Electric, Inc., Electronics Div., Industrial Park No. 1, Plainview, L. I., N. Y.*

CIRCLE 282 ON READER-SERVICE CARD

FLO-BALL 715
makes needle valves obsolete



WHICH VALVE CLOSES FASTER?

Unlike the many turns required to operate a needle valve, the Hydromatics ***FLO•BALL 715,*** shown on the bottom, closes instantly with a mere ¼ turn . . . **positive action** at flow pressures up to 3,000 psi with just a 10 inch-pound torque! And the arrow-shaped handle shows both open and closed positions at a glance. Exclusive ***FLO•BALL*** straight-thru design has maximum flow efficiency—more than double the flow of needle valves.

Ideal for leakproof control of air, vacuum, steam, water, fuels, oils, kerosene, alcohol, etc., the ***FLO•BALL*** features zero leakage, universal mounting, removable flanges, and all stainless steel construction.

Write today for a complete catalog describing this valve and others for corrosive and cryogenic media. Also special designs for throttling flow control.

The *FLO•BALL* costs no more than old fashioned screw-type valves!

Hydromatics, Inc.

BLOOMFIELD, N. J. • PILGRIM 8-7000 • TWX = BLOOMFIELD, N. J. 120

CIRCLE 101 ON READER-SERVICE CARD

Pressure: to 540 psi.

Ten orifice sizes: 3/64" through 1/4".

Wide voltage range: standard with 115V. AC.; also 12, 24, 208, 230, 460V. AC. 50/60 cycle.

Body: brass bar stock or 18-8 stainless steel. All moving parts, stainless. Seat disc, synthetic rubber. Sizes, 1/4" and 1/4" NPT. Both conduit and grommet types.

Underwriters' listed as a safety valve

Yes, "Master-mite" is the mighty mite of solenoid valves. Useable on a wide range of media including hydrogen, acetylene, etc. Works right in any position. Small, but with extra strength in the Marsh manner. Coils never overheat. Leak tight. Remarkably quiet.

Ask for special bulletin

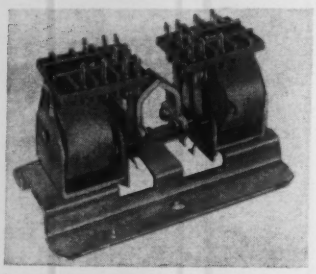
MARSH INSTRUMENT COMPANY
Division of Colorado Oil & Gas Corporation
Dept. 42, Skokie, Ill. Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta. Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas. Eastern Seaboard Warehouse: Marsh Instrument Company, 1209 Anderson Ave., Fort Lee, N. J.

MARSH

GAUGES • THERMOMETERS
VALVES

CIRCLE 102 ON READER-SERVICE CARD

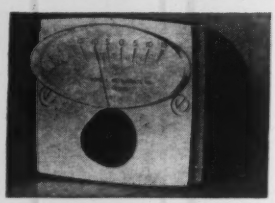
LATCHING RELAYS



New Type LGA (5-amp contact rating) and LGB (10-amp contact rating) electrical latch, electrical reset Latching Relays in a-c and d-c coil voltages have only two moving parts. SPDT (1C), DPDT (2C) and 3PDT (3C) contact arrangements are adaptable to many control and overload applications.—*Electronics Div., Elgin National Watch Co.*, 2435 *N. Naomi St., Burbank, Calif.*

CIRCLE 283 ON READER-SERVICE CARD

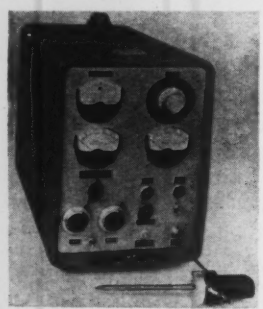
POINTER GALVANOMETER



New Model H2000 Pointer Galvanometer for use in panel or portable null-type instruments is taut-suspension, moving-coil instrument. Resistance values from 10 to 1000 ohms, sensitivities from 1.25 to 0.15 μamp/mm scale division are available. Period is 1.2 seconds.—*Howell Instruments, Inc.*, 3479 *W. Vickery Blvd., Fort Worth* 7, *Tex.*

CIRCLE 284 ON READER-SERVICE CARD

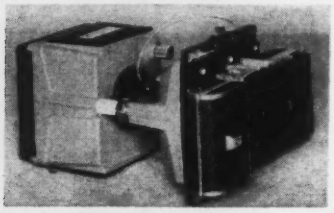
UNBALANCE INDICATOR



New portable Pulse Synchronized Unbalance Indicator (PSUI) electronically determines amount and angle of vibration caused by unbalanced rotating part. Filtering is by synchronous rectification circuits rejecting noise through operating range of 500 to 5000 rpm (standard), to 50,000 rpm (special.—*General Motors Research Laboratories*, 12 *Mile and Mount Rds., Warren, Mich.*

CIRCLE 285 ON READER-SERVICE CARD

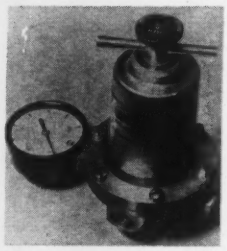
CAMERA



New C-13 Camera for direct recording of oscilloscope traces accepts Polaroid or conventional film, utilizes unique sliding back, 6 lenses in varying object-to-image ratios, and maximum aperture to f/1.5. Features one-hand portability, lift-on mounting, swing-away hinging.—*Tektronix, Inc., Box* 500, *Beaverton, Ore.*

CIRCLE 286 ON READER-SERVICE CARD

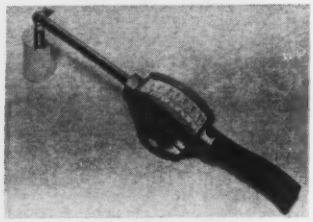
PRESSURE REGULATOR



New low-cost Regulator features precise repeatability and button control permits turning regulator on or off without disturbing adjustment setting. In "off" position, downstream pressure is reduced to zero; in "on" position, downstream pressure repeats to original setting.—*Benbow Mfg. Corp.*, 11920 *Jefferson Blvd., Culver City, Calif.*

CIRCLE 287 ON READER-SERVICE CARD

RADIATION PYROMETER



New KUSTOTHERM Surface Radiation Pyrometer for contactless temperature measurement of plastics, wood, etc. has swivel radiation head which can be directed against vertical, horizontal or slanted surfaces. Range is 125° to 480°F, subdivided in two ranges. Does not require batteries or any other power source. Bulletin. —*Epic, Inc.*, 150 *Nassau St., New York* 38, *N. Y.*

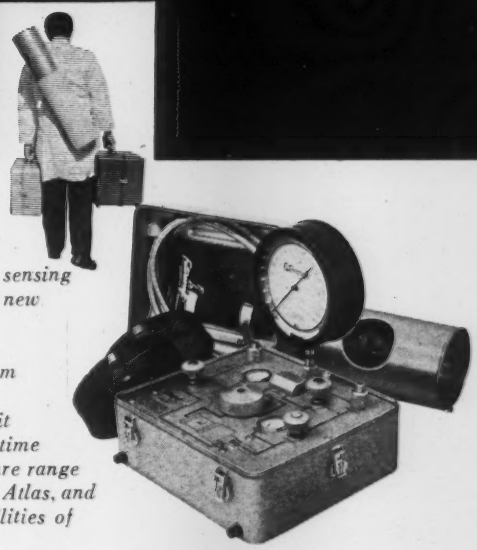
CIRCLE 288 ON READER-SERVICE CARD

For More Information on Products Listed Please Circle the Corresponding Number on the Readers-Service Card

A STITCH IN TIME.....

. . . can fly missiles on schedule . . . keep planes flying . . . and sustain industrial operations. Delays due to calibration verification of pressure sensing devices can now be eliminated completely with the use of Futurecraft's new "Cali-System" method of pressure calibration.

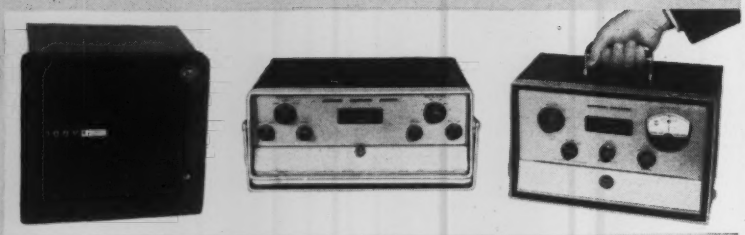
"Cali-System" now makes it possible to calibrate any pressure sensing device such as transducers, gauges, switches, etc., without removing them from the system and even while the system is functioning under full pressure. One man can carry the whole system — one man can operate it with complete safety . . . without contamination . . . in a fraction of the time normally required. Accuracies of one tenth of one percent over a pressure range of 0 to 10,000 PSI. Service and cost proven on such projects as Titan, Atlas, and Minuteman. Let us show you how to benefit from the amazing capabilities of "Cali-System" . . . write . . . for information today.



Futurecraft CORP. ▪ 15430 Proctor Ave., City of Industry, Calif. ▪ EDgewood 0-1611 ▪ TWX-CVNA 9653.

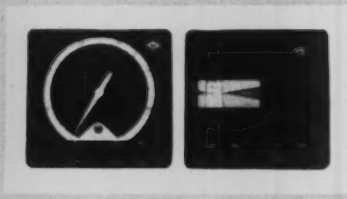
CIRCLE 103 ON READER-SERVICE CARD

NEW BLH-BUILT INSTRUMENTATION INSURES MORE ACCURATE, VERSATILE STRAIN GAGE TRANSDUCER READOUT



The complete line of mv/v instrumentation designed and built entirely by BLH now includes these new indicators for use with any strain gage transducer system.

Type 60 Digital Indicator, shown at left above, is particularly suited to load, pressure and torque systems. It provides system accuracy to ±0.25%—higher accuracies on special order. Designed for panel mounting or bench operation, it is available for fast delivery at a very reasonable cost. With the addition of this instrument, BLH now offers you a full choice of digital, disc or pointer indicators for industrial and laboratory applications.



Type 65 Automatic Calibration Indicator, middle above, is among the most accurate of all BLH instruments. This portable unit automatically reads out in pounds—is used to calibrate a variety of load measurement systems and features automatic null balance, digital readout, plus a built-in check calibrate circuit. Instrument accuracy ±0.05% of interval is standard.

Type 25 Universal Indicator can be used with any BLH load, pressure or torque transducer by simply setting a gage resistance and mv/v output dial on the front of the instrument. Manually null balanced—digital indication—transistorized, lightweight and portable. Instrument accuracy is ±0.1% of full scale. Durable Formica case.

Write for data sheets or contact your nearest BLH sales engineering representative for information and a demonstration.

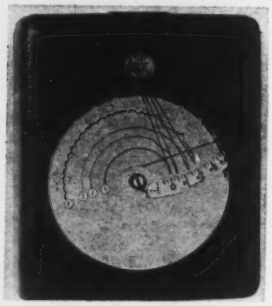
BALDWIN • LIMA • HAMILTON
Electronics & Instrumentation Division
Waltham 54, Mass.

FIRST in force measurement

SR-4® Strain Gages • Transducers • Temperature Sensors • Systems

CIRCLE 104 ON READER-SERVICE CARD

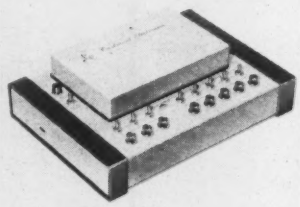
PERFORMANCE COMPUTER



New Bailey 710 Condenser Performance Computer produces continuous records of condensate flow, condenser back pressure, cooling water inlet temperature, and condenser back pressure deviation for evaluation of condenser operation. Analog computer plots family of predicated condenser performance curves to determine expected condenser back pressure for existing cooling water inlet temperature and condensate flow. Expected pressure is subtracted from measured actual pressure to give deviation from expected performance.—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.*

CIRCLE 289 ON READER-SERVICE CARD

PORTABLE CONTROL CENTER



New portable Control Center, which can be set up or modified quickly, is controlled by 8-channel punched tape. Each of 8 channels incorporates SPDT latching relay; relays are turned on or off automatically by control tape. Unit provides low-cost programming for metal-working equipment, etc.—*Crestmont Electronics Div., Crestmont Consolidated Corp., 2201 W. Burbank Blvd., Burbank, Calif.*

CIRCLE 290 ON READER-SERVICE CARD

ABSOLUTE VACUUM GAGE

New Vacuum Gage covers intermediate range of 0 to 10 mm between manometer and McLeod gage. Using principle of thin-wall float, pressure range is magnified approximately ten-fold to 100-mm scale length; has simple zero adjustment. Bulletin.—*Roger Gilmont Insts., Inc., 1 Great Neck Rd., Great Neck, N. Y.*

CIRCLE 291 ON READER-SERVICE CARD

Look to December 1961 issue of Instruments and Control Systems for expert treatment of this important control topic - - -

• CURRENT AND VOLTAGE CONTROL

ICS' READERS can look forward to a comprehensive display of highly informative and useful data.

MANUFACTURERS and designers of equipments and components for current and voltage control will find this a particularly valuable medium in which to advertise.

For ad and other details, contact our nearest rep — see list on page 1764.

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for more data on products advertised or reported editorially

1. **CIRCLE THE NUMBER, on one of the cards, that corresponds to the number appearing with the advertisement, new product description or new manufacturer's literature.**
2. **PRINT YOUR NAME, title, company, address, etc. clearly. Unreadable cards defy even punched card machines!**

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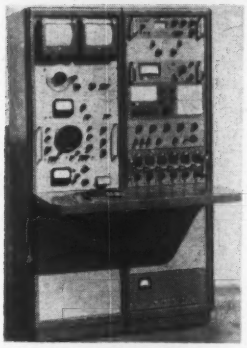
10/61

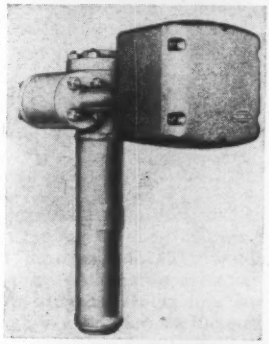
AMPLIFIER TEST CONSOLE



New Amplifier Test Console for 111 & 112 wideband d-c amplifier series has all inter-unit connections made so that amplifiers can be tested in their operational rack-modules. Test facilities also include cables and provision for external connections to permit bench operation for amplifiers requiring maintenance work. Tests eight amplifiers/hour.—*Kin Tel Div., Cohu Electronics, Inc., Box 623, San Diego 12, Calif.*

CIRCLE 292 ON READER-SERVICE CARD

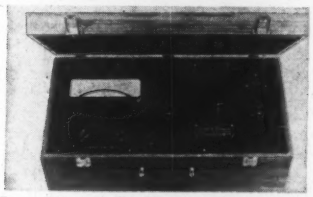
LIQUID LEVEL TRANSMITTER



New Liquid Level Transmitter transmits d-c signals proportional to level variations, features LVTD displacement transducer coupled with solid-state-circuitry amplifier. Accurate within 1%.—*Mason-Neilan, Div. Worthington Corp., Norwood, Mass.*

CIRCLE 293 ON READER-SERVICE CARD

AC VOLTAGE STANDARD



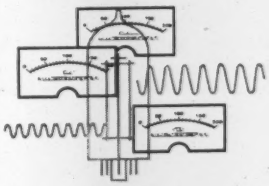
New Model FLH portable Thermocouple Transfer Standard measures frequency influence (or ac/dc differences) to accuracy of ±.01% from 1.5 to 1125 v over frequency span of 20 to 50,000 cps. Resolution is 0.005% min.—*Sensitive Research Instrument Corp., 310 Main St., New Rochelle, N. Y.*

CIRCLE 294 ON READER-SERVICE CARD

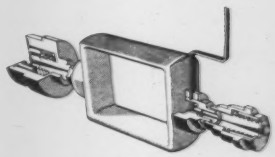
FULL-SCALE RANGES AS LOW AS 2μA OR MV; SPECIFIED LINEARITY OF ±0.5% OR BETTER

The new Series II Stylist panel meter is probably the most precisely linear production-model microammeter or millivolt-meter you can get. It can divide 2μa or mv into as many as 100 clearly legible slices with virtually no tracking error at all. With proper adjustment of full-scale current, it can give you infinitely accurate indication.

Its ultra-linearity is the result of individual scale calibration, made economically feasible by a newly-developed electronic calibrator. This calibrator, operating through a system of servo controls, automatically prints individually adjusted scales according to the actual measured tracking characteristics of each meter movement. Theoretically, each meter's full-scale linearity is infinite, with no tracking error at any point. (We do, however, retain a maximum ±0.5% manufacturing tolerance).



Added to this, you get a taut-band suspension, which accounts for the meter's 2μa or mv full-scale sensitivity and its near-perfect (±0.2% f.s.) repeatability. No friction. No hysteresis. High resistance to shock and vibration in any plane. Nearly impossible to wear out.



For full details on the API Series II Stylist, including ranges and prices, write for Bulletin 28.

api ASSEMBLY PRODUCTS INC. • CHESTERLAND 10, OHIO

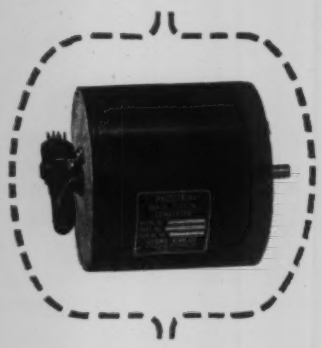
NEW!

THE SERIES II STYLIST TAUT-BAND PANEL METER

SA 2486

CIRCLE 105 ON READER-SERVICE CARD

PHOTOTRON



FIRST IN NEW LINE OF ANALOG TO DIGITAL CONVERSION PRODUCTS FROM HYDRO-AIRE

This highly versatile basic transducer offers incremental conversion of shaft angle to digital measurement. Available in seven models, its maximum permissible speeds range from 15,000 rpm at 128 counts per revolution to 1,250 rpm at 2,048 counts, with sample rates ranging to 45,000 counts per second.

Applications for the Hydro-Aire Phototron include analog to digital shaft converters, precision analog servo with digital readout, data reduction equipment, tachometers, and precision measurement and control.

Detailed specifications are available on request. Related products soon to be available from Hydro-Aire, a member of the Crane Co. Systems and Controls Group, will include associated power supplies and binary and digital counters.

HYDRO-AIRE
DIVISION OF
CRANE

3000 WINONA AVE., BURBANK, CALIF.

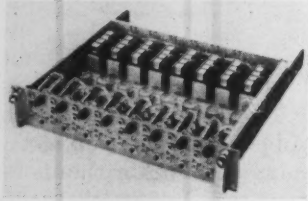
CIRCLE 106 ON READER-SERVICE CARD

CALIBRATION UNIT

New Model BC411 Isolated Balance & Calibration Unit for strain gage instrumentation systems features plug-in printed circuit card. Can be used with 6- or 8-wire transducer cables, single or double shunt calibration, with calibration steps of both polarities. Balance control is by screwdriver-adjust vernier potentiometer on front panel.—*Computer Engineering Assocs., 350 N. Halstead Pasadena, Calif.*

CIRCLE 295 ON READER-SERVICE CARD

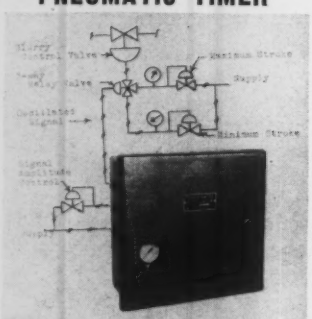
T/C SIGNAL CONDITIONER



New line of Thermocouple Signal Conditioning Equipment includes initial production Model TSC-1, modular 8-channel, rack-mounted unit that accepts signals from thermocouple reference junction, converts them to usable form for direct galvanometer monitoring. Power for biasing and calibration is supplied by mercury batteries mounted on unit; batteries are automatically disconnected during standby.—*Astra Tech Instrument Corp., Subs. Arnoux Corp., 12930 Panama St., Los Angeles 66, Calif.*

CIRCLE 296 ON READER-SERVICE CARD

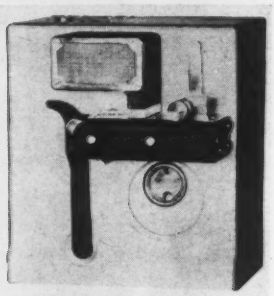
PNEUMATIC TIMER



New Servo-Gauge Oscillator pneumatically actuated Timer that uses air as moving part and requires no electrical connections, provides frequent, reliable unclogging of 1" slurry line in hydrocarbon processing unit manufacturing industrial chemical product. Cyclic operation of diaphragm control valve by pneumatic oscillator partially closes valve, then suddenly opens it to pre-set maximum position, freeing valve of clogging accumulations of slurry materials.—*Associated Control Equipment, Inc., Caraopolis, Pa.*

CIRCLE 297 ON READER-SERVICE CARD

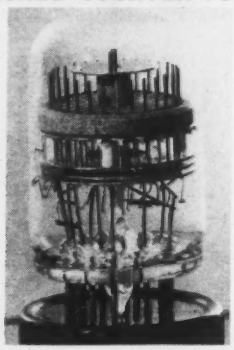
ANEMOMETER READER



New Anemometer (hot-wire) High Speed Tape Reader is for varying speeds from static to more than 500 ips. Sensing element combined with feed mechanism of Soroban GP-2 Super-Speed Tape Perforator reads character-by-character at speeds up to 300 codes/sec.—*Soroban Engineering, Inc., Box 1717, Melbourne, Fla.*

CIRCLE 298 ON READER-SERVICE CARD

DECADE COUNTER TUBE



New cold-cathode Decade Counter Tube Type CT4251 features 13-pin circle and wire pins suitable for transistorized and printed-circuit applications, ten output cathodes.—*Sylvania Electric Products, Inc., Subs. General Telephone & Electronics Corp., 730 Third Ave., New York 17, N. Y.*

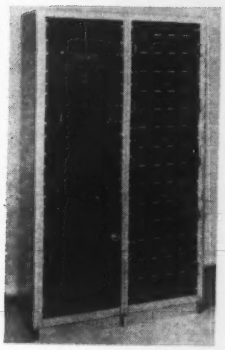
CIRCLE 299 ON READER-SERVICE CARD

HI-PRESS BALL VALVES

New screwed-end Ball Valves for liquids or gases at 2500 psi pressure and temperature between −40° and +180°F are available in sizes ¼" to 2" in carbon or alloy steels. Feature low torque, quarter-turn operation at high pressures, "Stelock" (new ball seal design with steel retained plastic which restricts cold flow or plastic deformation). Bulletin.—*Pacific Valves, Inc., 3201 Walnut Ave., Long Beach 7, Calif.*

CIRCLE 300 ON READER-SERVICE CARD

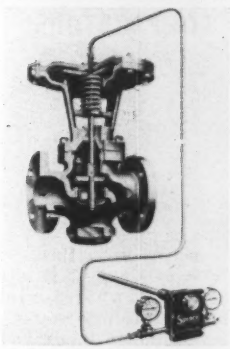
GAS FLOW MONITOR



New SD103 low-cost system for monitoring and recording gas flow from multiple remote stations features simplicity, ease of installation, long life, and minimum maintenance. Gas flow count is transmitted over commercial telephone lines and centrally displayed on individual 5- or 6-digit counters. (System shown records 60 points and is installed at Milwaukee Gas Light Co.) Bulletin SD103.—*Datex Corp., Box 667, Monrovia, Calif.*

CIRCLE 301 ON READER-SERVICE CARD

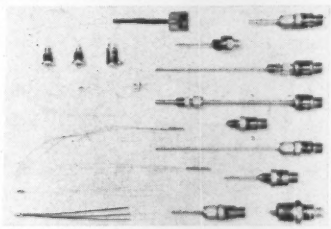
TEMPERATURE REGULATOR



New Type G2 Spence Main Valve controls at practically zero pressure drop. Single-seated sizes 2" to 8" with 125-lb flanges; double-seated sizes 10" and 12". Variety of pilots can be used with valve to control flow of steam, air, or water.—*Spence Engineering Co., Inc., Walden 2, N. Y.*

CIRCLE 302 ON READER-SERVICE CARD

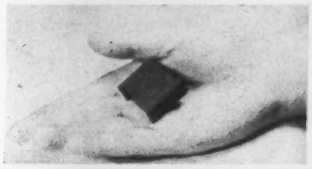
TEMPERATURE TRANSDUCERS



New line of Temperature Transducers has sensing elements of tungsten, platinum, copper, nickel, and other materials; withstands shock of 100 G at 11 ms, pressure 0 to 5,000 psi, vibration 20 G to 2,000 cps. Operate in practically any solid, gaseous or fluid medium. Accuracy is 0.1% of range.—*Temtro, Inc., 3016-C South Halladay, Santa Ana, Calif.*

CIRCLE 303 ON READER-SERVICE CARD

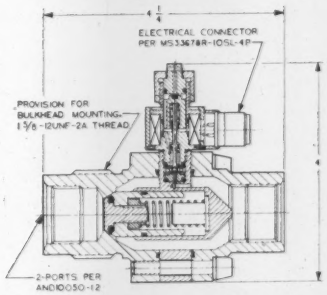
DATA SYSTEM



New MIDAS (Miniature Data Acquisition System) real-time FM/FM, multi-channel Telemetry System senses and transmits respiration rate, heartbeat, pressure, strain, acceleration, etc. Industrial applications include measurement of high-speed gas turbine strains and temperatures, forces acting on rotating helicopter-blades, dynamic pressure in steam turbines, etc.—*Unilectron, Inc., 129 Binney St., Cambridge 42, Mass.*

CIRCLE 304 ON READER-SERVICE CARD

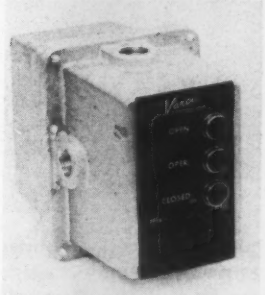
GAS VALVE



New V-38700 Series Gas Valve for 3,000-psi operation features minimum pressure drop, has main poppet seal of resilient Teflon. Maximum leakage of 4 cc/hr is standard. Electrical response times below 0.020 sec are possible with special solenoids; drop-out voltages above 3 vdc are standard.—*Valcor Engr. Corp., 365 Carnegie Ave., Kenilworth, N. J.*

CIRCLE 305 ON READER-SERVICE CARD

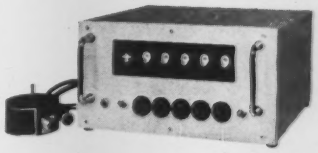
SUPERVISORY CONTROL



New Varelectric two-wire Supervisory Control System provides direct instantaneous control of pump motors, valve operators, etc. Principle of operation involves inherent polarization characteristics of d-c power source for remote control and special ability of Wheatstone bridge circuit to recognize conditions and direction of unbalance. Bulletin.—*Varec, Inc., 12923 S. Spring St., Los Angeles 61, Calif.*

CIRCLE 306 ON READER-SERVICE CARD

BI-DIRECTIONAL COUNTER



NEWEST IN NEW LINE OF ANALOG TO DIGITAL CONVERSION PRODUCTS FROM HYDRO-AIRE

This highly versatile, 45,000-count-per-second readout device indicates true position while going through zero in either direction. No need for external reset to establish reference, thus reducing the cost and complexity of related devices while simplifying system design and maximizing reliability. Modular construction of this compact, fully transistorized counter includes self-contained power supply and output connector.

When used with Hydro-Aire's Phototron transducer, this new counter converts inputs to Nixie tube visual readout and to digital type electrical readout for information storage, automatic machine control and process control systems — wherever precision numerical readout is required.

Detailed specifications on this and related products now available from Hydro-Aire are yours on request.

HYDRO-AIRE
DIVISION OF
CRANE

3000 WINONA AVE., BURBANK, CALIF.
Solid-state devices include time delay devices, voltage regulators, power supplies, inverters.

CIRCLE 107 ON READER-SERVICE CARD

* CALIBRATES A. C.
twice as fast
twice as fast
twice as fast

MODEL TV-1

* measures changes in A.C. input without transferring to D.C. . . . this permits operator to make frequency response checks in less than half the time previously required.

THERMAL TRANSFER VOLTMETER

NBS CERTIFIABLE

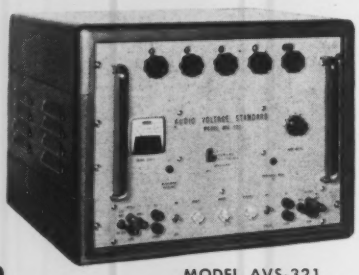
A new AC-DC transfer standard. Transfer measurement is made to a calibrated DC supply of the same voltage as the unknown AC being measured; thus eliminates ratio errors in the high frequency multiplier resistors.

Range — Three decade range multiplier. .5 volt to 1200 volts. Full resolution in 1 volt steps from 1 to 999 volts.

Frequency Response — .5 to 290 volts .02% to 50KC. 300 to 1200 volts .02% to 20KC. **Null Sensitivity** — .004%/mm.

Thermocouple — DC reversal error less than .02%. Couples, plug in replaceable, at $40.00. **Input Resistance** — 143 ohm/volt.

COMPLETELY VARIABLE A. C.



MODEL AVS-321

AUDIO VOLTAGE STANDARD

The output is continuously variable in frequency as well as voltage so that complete information about the response of the unit or system under test may be obtained.

Range — 1 to 1000 volts RMS 35 cps to 2 KC. 1 to 300 volts RMS 35 cps to 10 KC. **Accuracy** — Regulated voltage equal to dial setting ± (0.1% + 2 mv) From 300 to 1000 volts accuracy is ±0.25%.

Stability — 30 days. Long-term drift may be corrected by simple adjustment. **Internal Oscillator** — 60 cps. Other frequencies available on request.

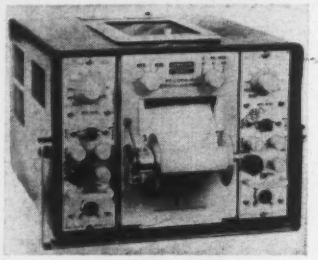
For further details write to

HOLT INSTRUMENT LABORATORIES

OCONTO, WISCONSIN

CIRCLE 108 ON READER-SERVICE CARD

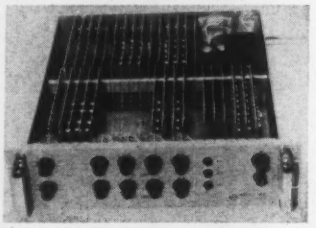
PORTABLE RECORDING SYSTEM



New METERITE 40-mm Amplitude Two-Channel Portable Rectilinear Recording System features interchangeable plug-in pre-amplifiers and new chart take-up unit. Model BSA-250 uses ink writing, Model BSA-260 electric writing in addition to ink. Unit consists of basic system assembly and any two interchangeable plug-in pre-amplifiers. Maximum undistorted ampltitude full scale is 40 mm, dc to 40 cps; half scale, dc to 80 cps; quarter scale, dc to 120 cps.—*Massa Div., Cohu Electronics, Inc.*, 280 *Lincoln St., Hingham, Mass.*

CIRCLE 307 ON READER-SERVICE CARD

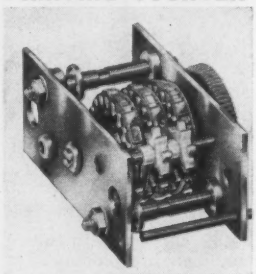
COMPARATORS



New Models 54 and 55 Digital Comparators, fully transistorized and equipped with mercury-wetted contact relays, determine if input voltage or series of voltages is within preset limits; convert data from digital measuring instruments such as a-c and d-c digital voltmeters, digital ratiometers, and digital ohmmeters into go/no-go form. Model 54 has four digits, Model 55 has five digits. —*Non-Linear Systems, Inc., Del Mar, Calif.*

CIRCLE 308 ON READER-SERVICE CARD

PRINTING COUNTER



New high-speed, add-subtract Printing Counter has three digits with additional digits or decimal points to suit requirements. Features printing speed up to 5,000 cts/min.—*Radson Engineering Corp., Macon, Ill.*

CIRCLE 309 ON READER-SERVICE CARD

RELIABLE TEMPERATURE CONTROL STARTS WITH L&N THERMOCOUPLES

. . . like the swaged couple shown, which offers the advantages of small size and fast response for a wide range of applications.

This is only one of L&N's complete line of thermocouples and accessories, designed for diverse applications in metalworking, chemical, ceramic, glass, power and other industries.

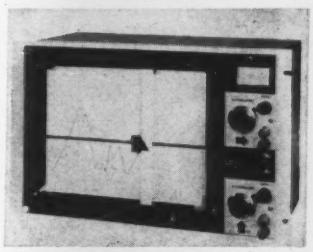
To get the best out of your L&N temperature instruments, be sure to use L&N thermocouples! You'll find it pays. For details on L&N's complete thermocouple line, ask your nearest L&N office for Catalog EN-S2. Or write Leeds & Northrup, 4955 Stenton Ave., Phila. 44, Pa.

LEEDS & NORTHRUP

Pioneers in Precision

CIRCLE 109 ON READER-SERVICE CARD

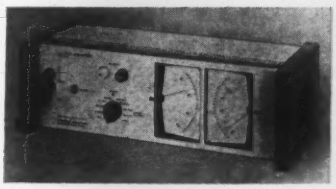
X-Y RECORDER



New Model HR-95 X-Y Recorder includes vacuum paper holddown, continuous 10-turn precision attenuators, electric pen lifter. Available with 1 or 10 mv/in amplifiers; also with 10- or 100-mv full scale amplifiers for 7" axis and 15- or 150-mv full scale amplifiers for Y axis.—*Houston Instrument Corp., Box 22234, Houston 27, Tex.*

CIRCLE 310 ON READER-SERVICE CARD

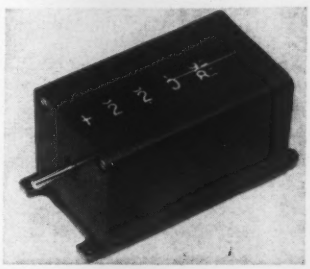
VOLT-OHMETER



New low-cost, semi-digital, solid-state Volt-Ohmeter Type 21A uses two conventional D'Arsonval meter movements so arranged that resolving power of one acts to multiply resolution and accuracy of other. Accuracy to three significant figures. Left-hand meter acts as digital indicator. Right-hand meter movement is connected to analog circuitry.—*J-Omega Co., Los Altos, Calif.*

CIRCLE 311 ON READER-SERVICE CARD

DECIMAL COUNTERS



New line of center scale Decimal Counters provides precision readouts of latitude and longitude positions and plus-or-minus quantities. Counters with Geneva drives have slewing speeds up to 1800 rpm.—*Kearfott Div., General Precision, Inc., 1150 McBride Ave., Little Falls, N. J.*

CIRCLE 312 ON READER-SERVICE CARD

For Added Information be Sure to Circle the Corresponding Number on the Reader-Service Card

SCAM® DE-LINE

THE ENGINEER'S ANNUNCIATOR

GREATEST FLEXIBILITY IN THE FIELD

AVAILABLE IN MANY SEQUENCES

BACKLIGHTED OR BULL'S-EYE

SIDE BY SIDE OR STACKED, DE-LINE modular design retains original custom appearance as system grows.

SAME PLUG-IN operates from normally open OR normally closed trouble contacts.

AUXILIARY CONTACTS N.O.-N.C. standard with most plug-ins.

SEQUENCE OPTION after installation by means of independent slide switch at each point.

DE-LINE plug-ins are self-policing. Systems are rugged and dependable.

THE SCAM INSTRUMENT CORP.

Dept. G, 3101 N. Lowell Ave. • Chicago 41, Ill.
AVenue 2-6930

REPRESENTATIVES IN ALL PRINCIPAL CITIES
COMPLETE MONITORING SYSTEMS FOR INDUSTRY

CIRCLE 110 ON READER-SERVICE CARD

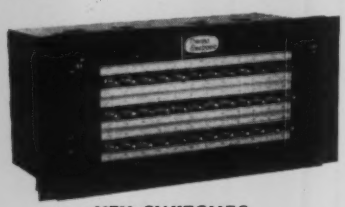
NEW Thermocouple Selector Switches

For fast, accurate indication of temperature from a number of thermocouples—to average readings from several measuring points—or to switch a thermocouple from one instrument to another—choose a new compact Thermo Electric Selector Switch.

These switches are compatible with any thermocouple or resistance thermometer, and any measuring instrument. Steel cases are dust and moisture proof, and are easily mounted on panel, rack, wall, or table.

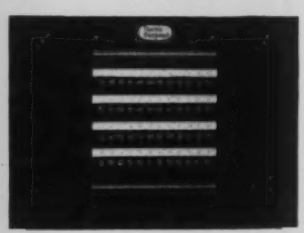
ROTARY SWITCHES

Capacities—OFF to 6, 12 or 24 measuring points. Available with binding post terminals or bunched leads for soldered connections.



KEY SWITCHES

Accommodate 1 to 144 sensing elements—locking or non-locking construction. Choose from several different cabinets.



PUSH BUTTON SWITCHES

OFF to 72 points—interlocking construction so that one switch remains "on" until another is actuated.

Write today for catalog 24-2-12

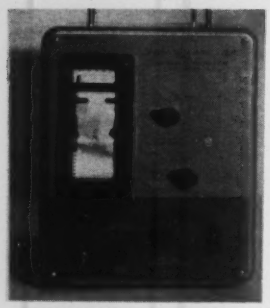
Thermo Electric CO., INC.

SADDLE BROOK, NEW JERSEY

In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

CIRCLE 111 ON READER-SERVICE CARD

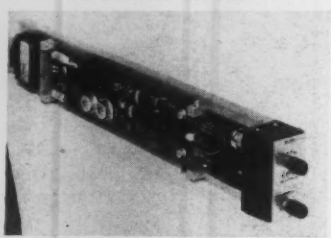
RECORDING WAVE ANALYZER



New Model 800 Recording Wave Analyzer performs complete waveform analysis over 20-to-20,000-cps range; measures amplitude of all frequency components in any waveform and records them on built-in strip chart recorder. Outputs of accelerometers, microphones, strain gages, pressure pickups, and similar transducers are rapidly analyzed. Bulletin. —*Optron Corp., 335 S. Salinas St., Santa Barbara, Calif.*

CIRCLE 313 ON READER-SERVICE CARD

DC AMPLIFIER



New Model 3101 chopper-stabilized wideband DC Amplifier accurately amplifies low-level signals from dc to beyond 20 kc. Plug-in attenuators provide fixed or adjustable gain settings between 10 and 1000, either differential or single-ended. Major specs: ±0.01% gain stability; less than 2 μv drift for 100 hr; 50 megohms (potentiometric) input impedance; ±15% at 100 ma output capability.—*PM Electronics, Inc., 5221 University Ave., San Diego 5, Calif.*

CIRCLE 314 ON READER-SERVICE CARD

AN/DIG CONVERTER

New Model M3 Multiverter analog-to-digital converter features reliability owing to solid-state design and low component count. Accuracy of conversion is within 0.05% ± ½ least significant bit with operating rate of 8000 conversions/sec for decimal output. Available as 13-bit model.—*Packard Bell Computer, Subs. Packard Bell Electronics, 1905 Armacost Ave., Los Angeles 25, Calif.*

CIRCLE 315 ON READER-SERVICE CARD

5,000 psi MERCOID PRESSURE CONTROLS

OPERATING RANGE
500 to 5,000 psi.

External Adjustment
Sealed mercury contact
Visible calibrated dial
Visible on-off circuit
Repetitive trip point

TYPES AVAILABLE

DXA-21
minimum differential 450 psi.
DXA-521
minimum differential 200 psi.
DXS-221
minimum differential 150 psi.

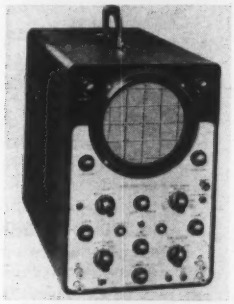
Available in three case styles;
General Purpose
Weather-Proof
Explosion-Proof

WRITE FOR BULLETIN O-21

THE MERCOID CORPORATION
4205 BELMONT AVENUE
CHICAGO 41, ILL.

CIRCLE 112 ON READER-SERVICE CARD

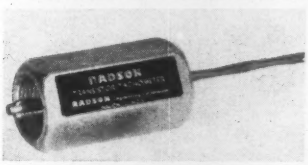
WIDE-BAND OSCILLOSCOPE



New Model ES-150 Wide-band Oscilloscope covers entire range between dc and 5 Mc. Vertical channel is 3-state push-pull balanced d-c amplifier; horizontal channel uses push-pull output amplifier having sensitivity of 0.6 v rms/in. Frequency response is within 3 db from 1 cps to 400 kc. Input impedance is 5 megohms shunted by 23 mmfd. Bulletin. —*Precision Apparatus Co., Inc., Glendale 27, N. Y.*

CIRCLE 316 ON READER-SERVICE CARD

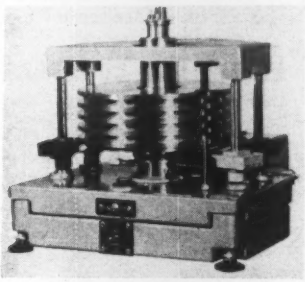
TACHOMETER GENERATOR



New Tachometer Generator permits use of transistor tachometers with diesel engines and other mechanical rotation applications; has no contacts. Can be safely operated in explosive ambients. Magnetically-induced output provides 2 v min at 500 rpm.— *Radson Engineering Corp., Macon, Ill.*

CIRCLE 317 ON READER-SERVICE CARD

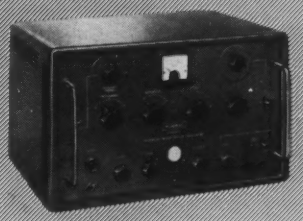
DEAD WEIGHT TESTER



New Dead Weight Pressure Tester Model 5100 is available in three designs and three pressure ranges up to 12,000 psi. Basic tester is equipped with piston-cylinder assembly, manually rotated weights, base and hand pump. Calibrated by direct intercomparison against NBS calibrated Dead weight gage; accurate to 0.04%; resolution is 0.02% or better.—*Ruska Instrument Corp., 6121 Hillcroft, Houston 36, Tex.*

CIRCLE 318 ON READER-SERVICE CARD

Accurate and Stable



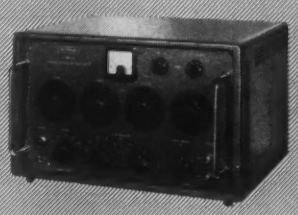
D - 890 - A (with crystal check)

Frequency: 1 c/s to 111.1 kc/s
Accuracy (max): 0.05% above 500 c/s; 0.005% at spot frequencies.
Output (max): 126v into 8k ohms or 24v into 600 ohms.

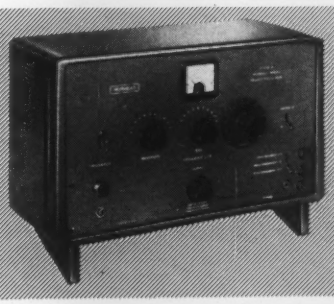
variable-frequency

D - 880 - A (2 phase)

Frequency: 0.01 c/s to 11.2 kc/s.
Accuracy: 0.2% above 5 c/s; 2% at 0.01 c/s.
Outputs: 10v into 10k ohms and 600 ohms.



Decade Oscillators



D - 695 - A

Frequency: 10 c/s to 31.2 kc/s.
Accuracy: 0.2% above 100 c/s; ±0.3 c/s at 10 c/s.
Output: 10v into 10k ohms; 2.4v into 600 ohms.

Models cover a frequency range from 0.01 c/s to 111.1 kc/s.

Write for Publications 130, 136, 137

MUIRHEAD

MUIRHEAD INSTRUMENTS INC., 441 Lexington Avenue, New York 17, N.Y., U.S.A. Telephone: Murray Hill 2-8131
MUIRHEAD INSTRUMENTS LIMITED, Stratford, Ontario, Canada
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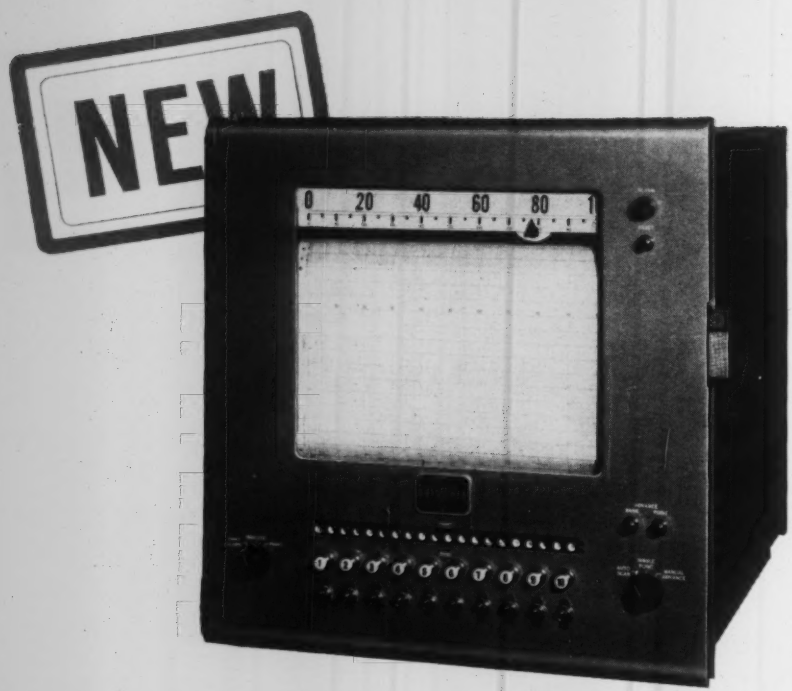
Telephone: Beckenham 4888

509/3

CIRCLE 113 ON READER-SERVICE CARD



New point-a-second alarm scanner

scans or records up to 200 variables
to detect off-normal conditions fast

The Dynamaster® Alarm Scanner combines high-speed scanning of any type of variable, continuous or off-normal recording, and multiple-alarm settings in a single monitoring instrument.

Check these Dynamaster capabilities against your alarm scanning requirements:

Positive alarm notification, provided simultaneously by:
(1) illuminating a red "alarm lamp" on instrument case
(2) energizing external visible and audible alarm signals
(3) automatic print-out of measured value and identification of the off-normal variable.

Alarm flexibility. Up to 20 individually adjustable potentiometers can be provided—permitting separate high and low settings for each of 10 variable groups.

Simplified operation. Any high- or low-alarm limit can be changed within 5 seconds. All operator selector switches are mounted on face of instrument. Scan cycle is traced by lamps on front of Scanner case.

Long instrument life is insured by transistorized design and precision mechanical construction. To prevent unnecessary wear, Dynamaster servo-balancing mechanism remains inoperative during scanning until an alarm condition is detected.

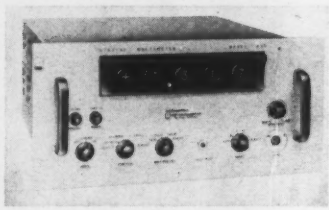
For complete details on these and other features of the new Dynamaster Alarm Scanner, write to: 119

THE BRISTOL COMPANY
Waterbury 20, Connecticut
Or nearest Bristol Branch Office

BRISTOL'S
THE DATA-MASTER CORPORATION
Subsidiary of The Bristol Company, Waterbury 20, Conn.
ACCO

CIRCLE 114 ON READER-SERVICE CARD

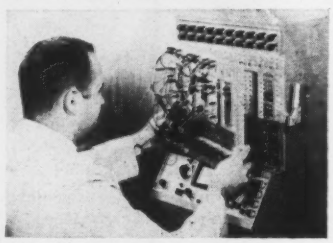
VOLTMETER/RATIOMETER



New EItronic 850 four-digit Multiple Meter measures d-c volts, d-c ratios, and a-c volts utilizes solid-state circuitry. Decimal point placement and d-c signal polarity are determined automatically and displayed with digital value of input signal on 3-position tilting readout. D-c voltage range, d-c ratio range, and a-c voltage range are each 0.0001 to 999.9; d-c voltage accuracy and d-c ratio accuracy, ±1 digit; a-c voltage accuracy: ±0.1% or 2 digits.—*Electro Instruments, Inc.,* 8611 *Balboa Ave., San Diego* 11, *Calif.*

CIRCLE 319 ON READER-SERVICE CARD

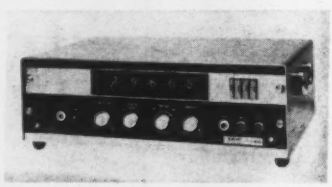
REMOVABLE COMPUTER PANEL



New Removable Panel for TR-10 general purpose analog computers permits problems to be programmed in advance. Pre-programmed panel can be removed and another installed in less than 1 minute. (Normally, problems take 20 to 30 min to program directly on computer's patch panel.)—*Electronic Associates, Inc., Long Branch, N. J.*

CIRCLE 320 ON READER-SERVICE CARD

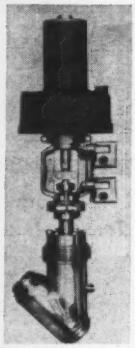
FREQUENCY COUNTER



New Model 740 Frequency Counter and Preset Translator offers rapid readout of unknown quantities by translating pulses-per-unit-time into physical units-per-unit-time (lb/hr, gpm, ft/sec, rpm, etc.) In-line NIXIE readout in 4, 5, or 6 decades oven-stabilized crystal, preset digital time base, manual or automatic recycling. —*Erie-Pacific Div., Erie Resistor Corp.,* 12932 *S. Weber Way, Hawthorne, Calif.*

CIRCLE 321 ON READER-SERVICE CARD

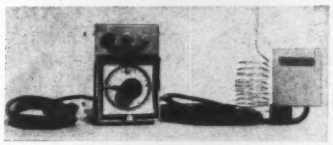
LIQUID HYDROGEN VALVE



New liquid-hydrogen Valve for cryogenic applications comprises Y-pattern valve body and 2-positioner pneumatic actuator with stainless-steel vacuum jacket. Globe and angle configurations, large C_v.—*Security Valve Co., Subs. Menasco Mfg. Co., 909 El Centro St., South Pasadena, Calif.*

CIRCLE 322 ON READER-SERVICE CARD

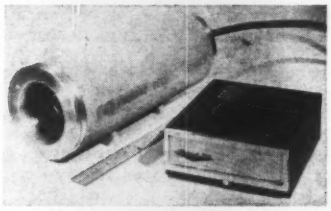
LIQUID NITROGEN CONTROL



New automatic Liquid Nitrogen Controller Model NCT-5 eliminates manual filling of liquid-nitrogen traps, containers, etc. Vapor-charged remote sensing bulb actuates switch which in turn energizes solenoid during filling cycles. Plug-in timer regulates high liquid level, provides instant interchangeability.—*Almac Cryogenic Air Co., 1108-26th St., Oakland 7, Calif.*

CIRCLE 323 ON READER-SERVICE CARD

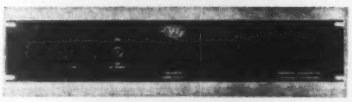
CCTV CAMERA



New Closed-Circuit Television high-resolution Camera System Series 2900 is enclosed in environmental type container which eliminates need for special housing. Etched boards of epoxy impregnated fiberglass provide high indestructibility ratio.—*Packard Bell Electronics, 1920 S. Figueroa St., Los Angeles 7, Calif.*

CIRCLE 324 ON READER-SERVICE CARD

WIDEBAND CONVERTER

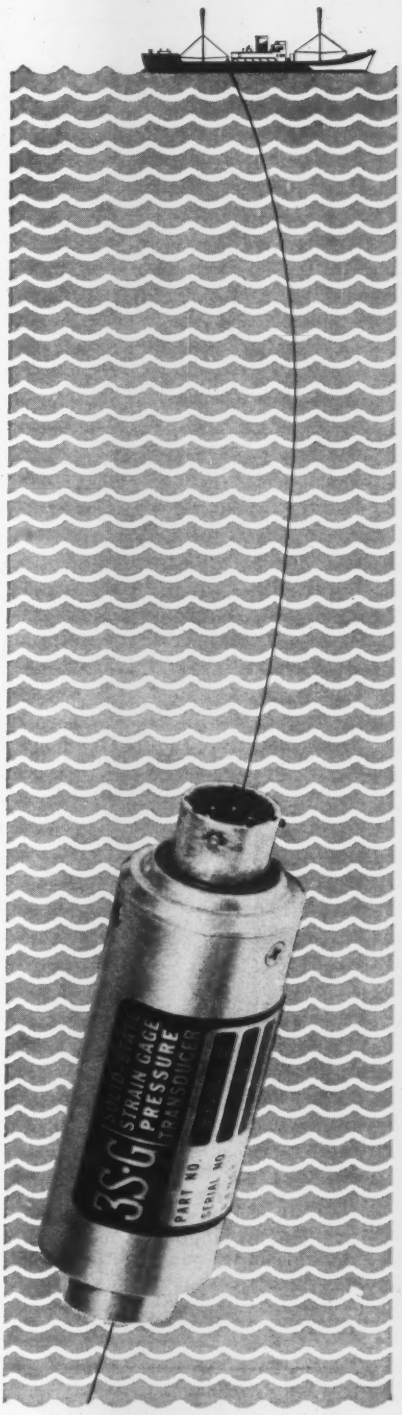


New VLF-1 Caliverter provides reception of VLF signals on standard HF communications receiver, is useful in systems that require accurate time and cannot tolerate erratic reception of HF standard time signals. Sensitivity is less than 0.1 μv; output is at 5.000 Mc plus VLF frequency.—*Aerospace Research, Inc., 94 Massachusetts Ave., Cambridge 39, Mass.*

CIRCLE 325 ON READER-SERVICE CARD

LONG LINES NEED STRONG SIGNALS

THE 3S-G SILICON SEMICONDUCTOR STRAIN-GAGE PRESSURE TRANSDUCER

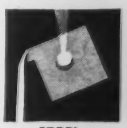


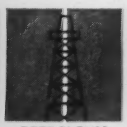
Has a Signal Output of 5 v. d. c.

For remote pressure measurement via long lines—under water or above ground—you need a transducer that delivers a high-output signal without additional amplification. The only answer is the new Fairchild 3S-G. It has a 5 v. d.c. output. And it uses semiconductor materials with piezoresistive characteristics as a sensing element.

Extraordinarily accurate (±.003%/degree F error band is not uncommon) in the roughest environment, the tough 3S-G has infinite resolution, self-contained calibration, temperature compensation, and unexcelled repeatability. It is also available with low output (5mv. to 5 v. d.c.), low-pressure gage and absolute (0-10 to 0-100 p.s.i.), high-pressure gage and absolute (0-100 to 0-10,000 p.s.i.), and high-line low-differential (±10 to ±10,000 p.s.i.d.). All versions operate from —65° to 250°F in practically all gaseous and liquid media, including liquid oxygen, strong alkalies, corrosive acids, and high-energy fuels. All are designed to replace strain-gage pressure transducers now being used by industry and the military.

For more information about the 3S-G silicon-semiconductor strain-gage pressure transducer, write Dept. 51 ICS.


STEEL


PETROLEUM

CHEMICAL

wide application in control systems for defense & industry

MISSILE

UNDERWATER

FAIRCHILD CONTROLS CORPORATION

a Subsidiary of Fairchild Camera & Instrument Corporation

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ANOTHER FINE PRODUCT OF FAIRCHILD RESEARCH

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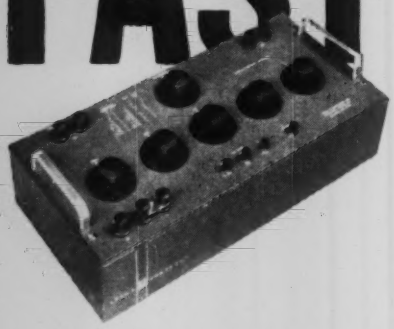
FAST



. . . accurate D-C resistance measurements with L&N's 4735 Guarded Wheatstone Bridge

Perform laboratory experiments, make routine resistance measurements or calibrate resistors faster—more accurately—with L&N's 4735 Guarded Wheatstone Bridge.

This advanced instrument has many new features including: high accuracy with a wide operating range . . . guarding of detector circuit to prevent resistance errors due to humidity effects . . . minimizing of thermals by special construction features . . . elimination of tedious plug and block ratio settings due to use of a single rotary switch.

List No. 4735 Guarded Wheatstone Bridge, *normally available for delivery from stock.*

Range—*0.01 ohm to 1,111 megohms.*

Limit of Error—*±(0.05% + 0.001 ohm) up to 100 megohms; ±0.5% above.*

Rheostat Switches—*Five decades of enclosed switches in steps of 10 x (1000 + 100 + 10 + 1 + 0.1).*

Multiplier Dial–*Eleven-position enclosed switch. Multipliers: 10^{-5} to 10^{5}.*

Current Rating *(of rheostat arm used as resistance box, determined by highest decade in use)—For 0.1Ω, 1.1 amp; for 1.0Ω, 0.35 amp; for 10Ω, 0.11 amp; for 100Ω, 0.035 amp; for 1000Ω, 0.011 amp.*

Galvanometer Sensitivity Keys — *Three tap keys provide sensitivities of approximately 1, 1/100 and 1/1000. A battery reverse key is provided.*

Case—*Metal, gray enamel finish; 19" x 9" x 7" for bench use. Wt. is 13 lbs.*

Price—*$475.00 f.o.b. Phila. or North Wales, Pa. (subject to change without notice). Order List No. 4735 from L&N, 4955 Stenton Ave., Phila. 44, Pa.*

LEEDS & NORTHRUP Instruments · Automatic Controls · Furnaces

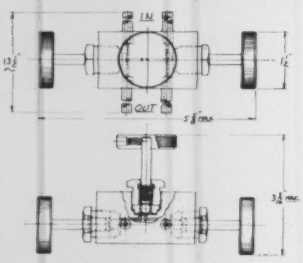
CIRCLE 116 ON READER-SERVICE CARD

DECIMAL INDICATORS

New 500-Series transistorized Decimal Indicators accept 0.1-mw binary-coded-decimal inputs and produce projection-type decimal display; 3 to 6 digits, with parallel or serial inputs. Also, similar 1000-Series indicators accept binary input data and provide decimal display.—*Howard Instrument Co., Red Bank, N. J.*

CIRCLE 326 ON READER-SERVICE CARD

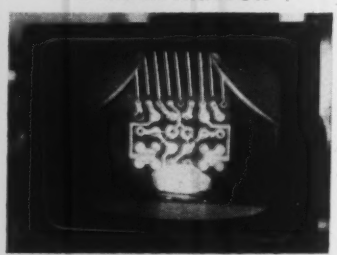
THREE VALVE MANIFOLD



New high-pressure three-valve Manifold incorporates two block valves and one bypass valve. Hand-operated packless unit (with ¼" OD tubing connections) is constructed of 303 and 316 stainless steel. Also available in one-, two-, four-, or five-valve styles.—*G. W. Dahl Co., Inc., 86 Tupelo St., Bristol, R. I.*

CIRCLE 327 ON READER-SERVICE CARD

TV COMPARATOR



New Television Comparator permits precise measurement of miniature solid objects with magnification up to 300 X. Specially designed CVTV system allows positioning image on screen and changing its magnification through entire range without loss of focus.—*General Precision, Inc., 63 Bedford Rd., Pleasantville, N. Y.*

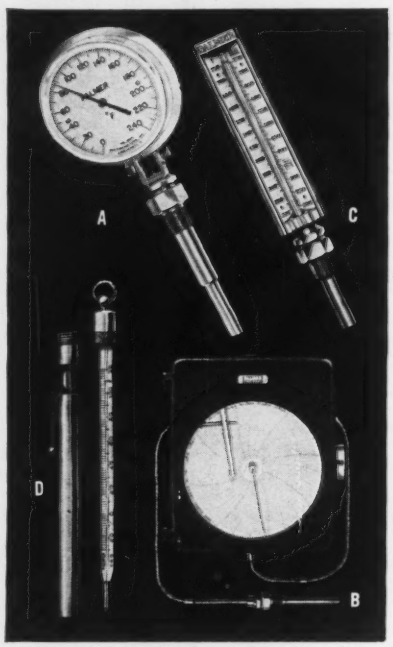
CIRCLE 328 ON READER-SERVICE CARD

For More Information
Circle Correct Number
on Reader Service Card

A GREAT NAME IN THERMOMETERS

PALMER

Mercury Actuated Temperature Indicating Instruments



A—4½" DIAL THERMOMETERS: Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

B—RECORDING THERMOMETERS: Twelve inch die-cast aluminum case with black finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges: −40 +950° F or Equivalent in °C.

C—INDUSTRIAL THERMOMETERS: Red-Reading Mercury—Extruded brass case—chrome finish. Ranges: −40 +950° or Equivalent in °C.

D—RED-READING MERCURY LABORATORY THERMOMETERS: Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

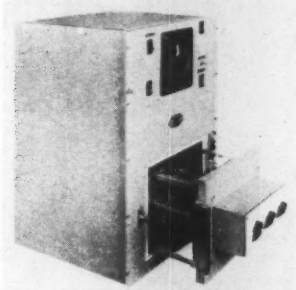
FOR COMPLETE INFORMATION WRITE FOR CATALOG

PALMER

PALMER THERMOMETERS, INC.
Cincinnati 12, Ohio • MElrose 1 1500

CIRCLE 117 ON READER-SERVICE CARD

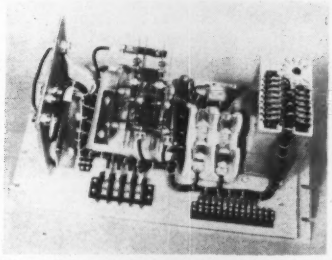
PORTABLE TEST CHAMBER



New PR Chamber, hi-low temperature unit, operates from −100° to +600°F using liquid CO_2 as coolant. Test volume is over 1000 cu in. Indicating thermostat provides close temperature control. Bulletin.—*Gruenberg Electric Co., Inc., 9 Commercial Ave., Garden City, N. Y.*

CIRCLE 329 ON READER-SERVICE CARD

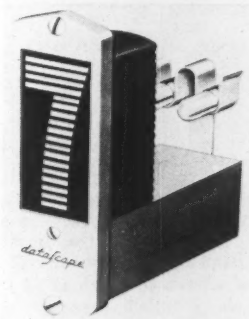
LINEAR POWER CONTROLLERS



New Linear Power Controllers for electric furnaces combine magnetic amplifier-silicon controlled rectifiers on single functional panel. D-c output versions are used as preamplifiers for saturable-core reactors in furnace range up to ½ Mw. Three a-c output versions deliver 550, 1650, or 6000 w directly into furnace loads. Catalog.—*Norbatrol Electronics Corp., 356 Collins Ave., Pittsburgh 6, Pa.*

CIRCLE 330 ON READER-SERVICE CARD

MINI DIGITAL READOUT



New self- decoding Readout decodes either binary inputs or pulse trains, displays information in digital form. Sixteen ¾" x 1¼" alpha-numerical characters are displayed at any rate up to 50 characters/sec.—*Datascope Corp., 4023 Irving Place, Culver City, Calif.*

CIRCLE 331 ON READER-SERVICE CARD

Take the legwork out of liquid measurement

Here's practical liquid measuring—the modern way... without roaming all over the lot! Liquidometer Gauges let you inventory distantly stored liquids at a glance.

Completely automatic Liquidometer Gauges can be located as far as 250 feet from tanks. Think what this centralized system can mean in man-hours saved—let alone the additional safety of personnel who no longer have to trudge to, or tamper with, hard-to-get-at tanks.

Simple to install, and requiring no maintenance, Liquidometer Gauges measure virtually all liquids conveniently, continuously, and correctly. There's a type available for practically every liquid measuring application.

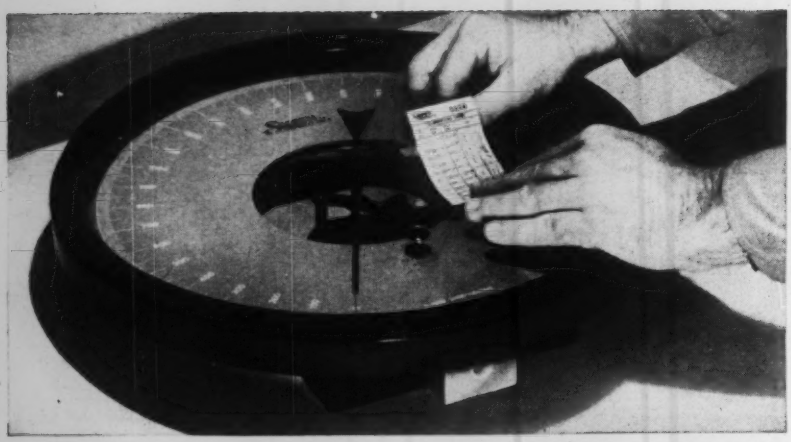
For complete details, write

LIQUIDOMETER INSTRUMENTS

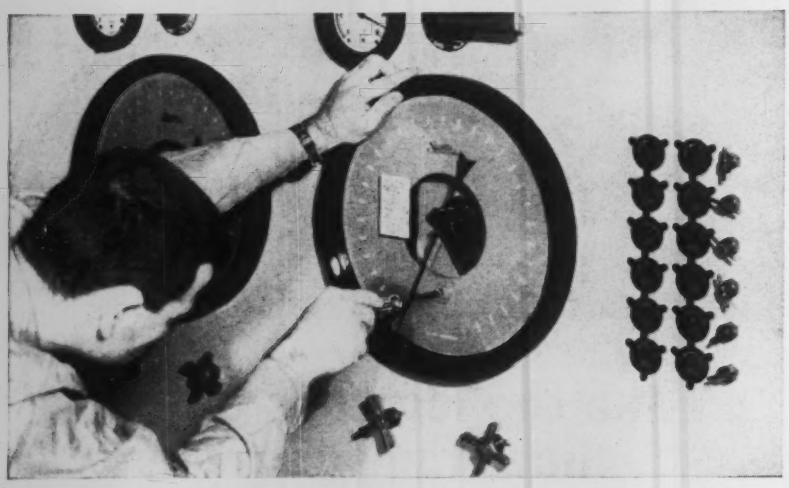
THE LIQUIDOMETER CORP.

Dept. E, LONG ISLAND CITY 1, NEW YORK

CIRCLE 118 ON READER-SERVICE CARD



Guaranteed accurate not only when it leaves our factory but also after field recalibration

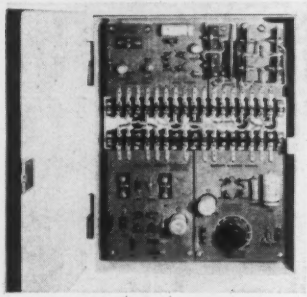


You can recalibrate Seegers precision test gauges to their original accuracy of 0.10% FS over their entire pressure range. Simple screwdriver adjustment takes only a few seconds and requires no special tools or testing equipment. Only Seegers gauges have this *true* recalibration capability. Other product superiorities include Ni-Span C and stainless steel components, eye-ease green dial with white increments linear to ±.001", and bourdon bleed and flush valve as standard equipment. *Write for a copy of our comprehensive technical bulletin.* **Seegers Instrument Company**

515 West Main Street, Barrington, Illinois SGS-1-200

CIRCLE 119 ON READER-SERVICE CARD

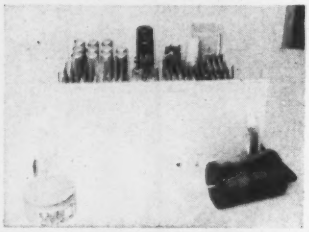
PROPORTIONAL POWER SYSTEM



New Proportional Power Magnetic Amplifier coupled with standard saturable core reactor is electrical equivalent of equal-percentage valve, in that linear change in system input produces percentage change in process power. Unit takes signals from any control systems with 0-5 ma output, process voltage and current, and combines these in D77312 magnetic amplifier whose output is fed to control winding of standard saturable reactor, changing typical characteristic curve of saturable reactor to proportional power relationship.—*Hevi-Duty Electric Co., 304 Hart St., Watertown, Wis.*

CIRCLE 332 ON READER-SERVICE CARD

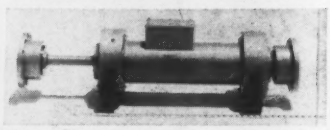
ENCODER READOUT SYSTEM



New Encoder Readout System for high accuracy measurements on comparator units has encoder unit with 3 separate discs. First has 1000 parts per turn, second and third each have 100 parts/turn. Encoder has potential resolution capabilities of 1 part in 10^7.—*Wang Laboratories, Inc., Natick, Mass.*

CIRCLE 333 ON READER-SERVICE CARD

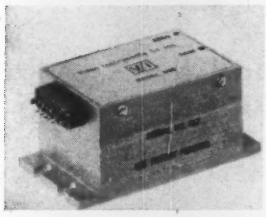
HORSEPOWER METER



New Meter measures horsepower transmitted by rotating shaft. Transducer sensitive to product of speed x torque is coupled directly between driving machine and load, producing 0-to-20 vdc output signal proportional to horsepower. Basic model is rated 600 hp, others available from 50 to several thousand hp over wide speed and torque ranges, with accuracy of 1%.—*Waugh Engineering Div., Foxboro Co., 7740 Lemona Ave., Van Nuys, Calif.*

CIRCLE 334 ON READER-SERVICE CARD

DC AMPLIFIERS



New Model 99-series and Model 98-series sub-miniature signal-conditioning DC Amplifiers raise millivolt signals from strain gages, bridge-type pressure transducers or bridge-type accelerometers to 5-v level. Output voltage can swing from zero to ±5 vdc. Frequency response extends from 0 to 2,000 cps.—*Video Instruments Co., Inc.*, 3002 *Pennsylvania Ave., Santa Monica, Calif.*

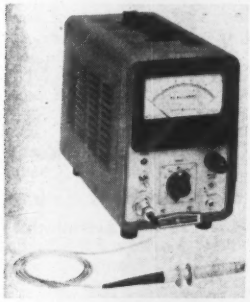
CIRCLE 335 ON READER-SERVICE CARD

RECORDER

New portable Tipptronic Universal Recorder records any number and combination of variables with single recording mechanism and strip chart. On 2-channel recorder recording is made every 2 seconds; on multiple-channel units, scan rates are from 2 to 12 sec/channel.—*Tipptronic, Inc.*, 510 *E. Washington St., Chagrin Falls, Ohio.*

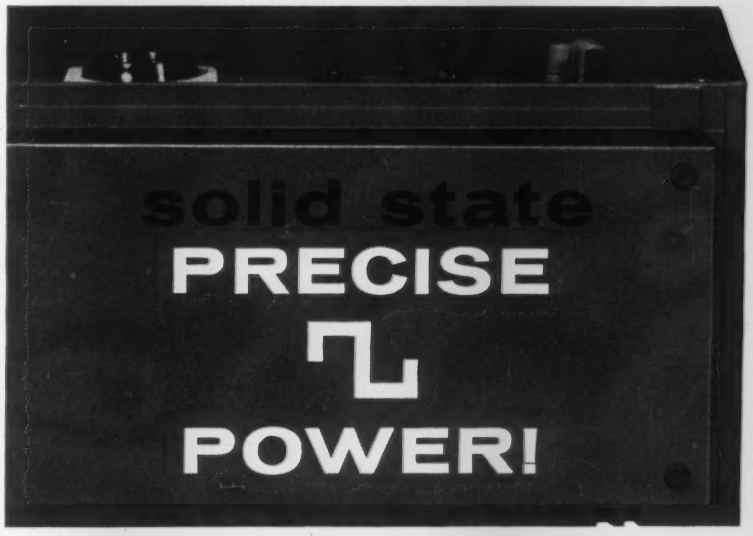
CIRCLE 336 ON READER-SERVICE CARD

CLIP-ON DC AMMETER



New wide-range Milliammeter Model 428B measures dc 0.3 ma to 10 amp in 9 steps without interrupting or loading circuits. Features clamp-on probe. Measures dc in presence of a-c signals, also measures sums or differences of currents in separate wires. —*Hewlett Packard Co.*, 1501 *Page Mill Rd., Palo Alto, Calif.*

CIRCLE 337 ON READER-SERVICE CARD



RISE AND FALL TIME—250 NANOSECONDS!

SYMMETRY—500 NANOSECONDS!

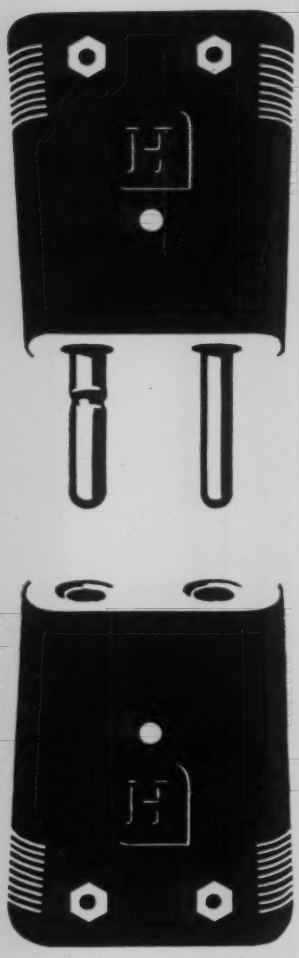
Now—ELIN'S fully-transistorized square wave power unit, model SQP106T, gives you the new dimension of precision you need, can depend on, for missile systems checkout, gyro and synchro testing, etc. Enjoy having ELIN performance superiority, versatility, compact size—working for you soon!

ELIN
Model
SQP106T

WRITE TODAY FOR COMPLETE ELIN SOLID STATE DATA FILE!

elin DIVISION
International Electronic Research Corporation
135 West Magnolia Boulevard, Burbank, California

CIRCLE 120 ON READER-SERVICE CARD



QuiK-Konnect PLUGS AND JACKS

New Honeywell QuiK-Konnect Plug and Jack Assemblies provide fast, foolproof connection of thermocouples to extension wire, and thermocouple extension wire to instruments. Inserts of different diameter positive and negative poles insure correct polarity every time. Inserts are easily removed for field calibration change or replacement, and can be furnished in different metals to match thermocouple alloy. Honeywell Quik-Konnect Accessories include identos, cable clamps, and tube adapters.

Get complete details from your nearby Honeywell field engineer, or write today for Specification Sheet FS 005-3. Minneapolis-Honeywell, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

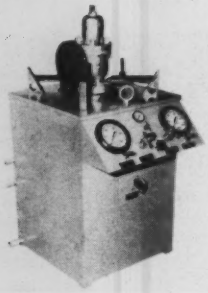
Honeywell

First in Control

SINCE 1885

CIRCLE 121 ON READER-SERVICE CARD

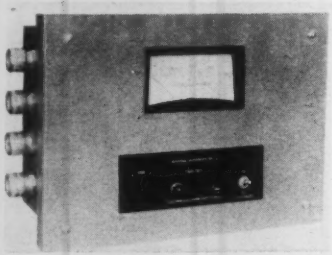
VALVE TEST STANDS



New Model 1000-S Valve Test Stand made by Piping Engineering Co. features single universal mounting plate. Tests all types of valves hydrostaticaly or pneumatically; hydrostatically tests pumps, exchangers, heaters, vessels, piping, etc.—*Crosby Valve & Gage Co., Wrentham, Mass.*

CIRCLE 338 ON READER-SERVICE CARD

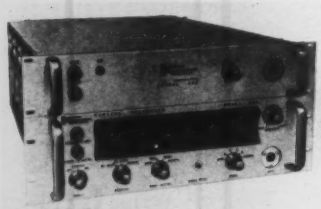
SOLUTION CONDUCTIVITY



New Electrodeless Conductivity System Model RS-2 indicates on 0 to 200 μa d-c scale.—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.*

CIRCLE 339 ON READER-SERVICE CARD

AC CONVERTER



New EItronic 882 five-digit transistorized AC/DC Voltmeter/Ratiometer develops d-c output voltage proportional to average value of input signal. Switching is by semiconductor devices. D-c ratio range, a-c voltage range, d-c voltage range, ±0.0001 to ±999.99; a-c frequency range, 30 to 10,000 cps; a-c accuracy, ±0.1% of reading or 2 digits; d-c accuracy, ±0.01% of reading or 1 digit (includes linearity, resolution, sensitivity, etc.)—*Electro Instruments, Inc., 8611 Balboa Ave., San Diego 11, Calif.*

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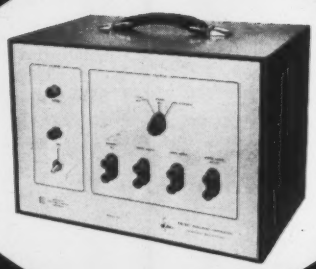
ACCURACY AND RELIABILITY EVEN UNDER FIELD CONDITIONS

DC VOLTAGE/CURRENT STANDARD



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1, 1.0185, 10 VOLT OUTPUTS

0.02% ABSOLUTE ACCURACY
7.5 and 10 MIL OUTPUTS

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- ZENER AGING CURRENTS
- INSTRUMENT CALIBRATION
- SYSTEM REFERENCE
- PRODUCTION LINE TEST
- STANDARDS LABORATORY

Based on advanced zener techniques and operational amplifiers, the Rotek Model 401 offers the ultimate in accuracy and stability available in a DC secondary standard. The Rotek DC Standard is designed for Mil Spec environment and may be used under field conditions with accuracy and reliability assured.

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Other Rotek instruments:
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AC/DC Comparators
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System References

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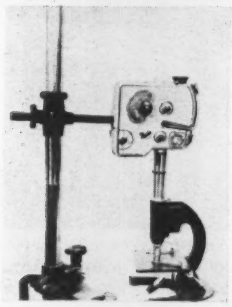
CIRCLE 122 ON READER-SERVICE CARD

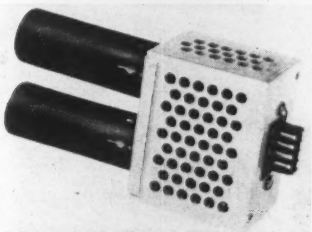
MICRO-CINEMATOGRAPHY



New Micro-adapter attaches CAMEX 8mm single-lens reflex movie camera to any microscope, replacing microscope's eyepiece. By focusing on parallax-free serial image of system, microscopic cinematography is easily accomplished.—*Karl Heitz, Inc.*, 480 *Lexington Ave., New York* 17, *N. Y.*

CIRCLE 341 ON READER-SERVICE CARD

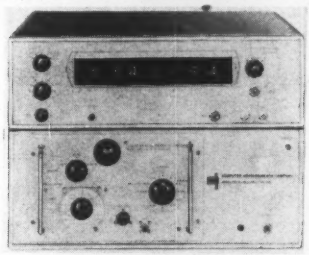
FOLLOWER AMPLIFIER



New plug-in Follower Amplifier Model K2-BJ, booster for operational amplifiers K2-WJ and K2-YJ, provides increased steady-state output of 20 ma at ±100 v, gain about 0.8, output impedance about 250 ohms (before feedback); features two premium grade 10,000-hr computer tubes. 2¾" x 1½" x 4⅞".—*Philbrick Researches, Inc.*, 127 *Clarendon St., Boston* 16, *Mass.*

CIRCLE 342 ON READER-SERVICE CARD

DIGITAL FREQUENCY METER



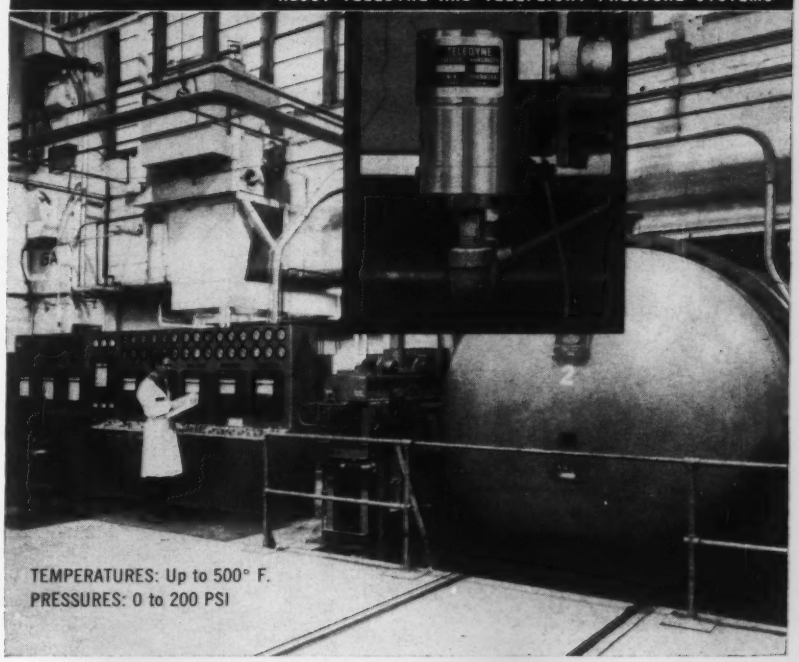
New 500-Mc Frequency Meter Model 737C couples completely transistorized 10-Mc frequency counter and vacuum tube heterodyne receptacle which accepts various converter plug-in units. Three plug-ins are available: Model 731B for 10-100-Mc range; Model 732B for 100-220-Mc range and Model 733B for 100-510-Mc range. Model 737C available with vertical decade display or inline Nixie readout.—*Computer Measurements Co.*, 12970 *Bradley Ave., San Fernando, Calif.*

CIRCLE 343 ON READER-SERVICE CARD

Taber®

TELE-NEWS

ABOUT TELEDYNE AND TELEFLIGHT PRESSURE SYSTEMS



Taber Transducer keeps close tab on autoclave air pressures at Twin Coach

The dependability and accuracy of Taber Bonded Strain Gage Pressure Transducers are pointed up in the manufacture of bonded aircraft assemblies at Twin Coach Co., Buffalo, N. Y.

Assemblies are bonded at temperatures up to 500° F inside a 12' x 37' autoclave where atmospheric conditions must be precisely controlled. Mounted externally to permit this high temperature application, a Taber Model 217 Teledyne Pressure Transducer senses autoclave air pressures from 0 to 200 psi, accurately and continuously. *Quality of manufacture is thus insured!*

Among the many performance pluses of Taber Transducers are high frequency response, minimum hysteresis, infinite resolution and low sensitivity to temperature effects, vibration and shock. Models are produced for a wide variety of test, ground support, or airborne applications, with pressure ranges from 0-50 to 0-10,000 psi.

For detailed information on Taber Transducers, mail this coupon attached to your letterhead.

TO: TABER INSTRUMENT CORPORATION
AEROSPACE ELECTRONICS DIVISION SECTION 243
107 Goundry Street, North Tonawanda, N. Y.

Send detailed information on Taber Teledyne and Teleflight bonded strain gage pressure transducers.

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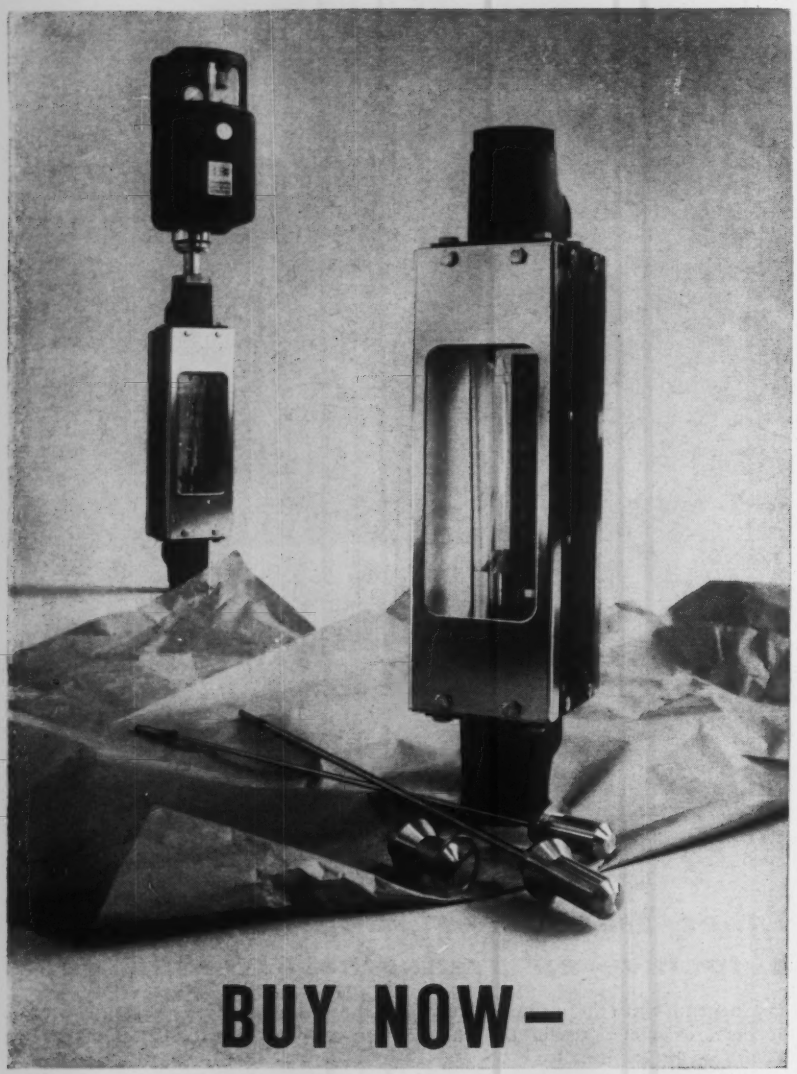

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TRANSMIT LATER

The Brooks Full-View® rotameter has a remarkable ability to adapt to changes in process requirements.

With the addition of a float extension and a Brooks Series MPT unit, it can become a pneumatic or electric transmitter. Or, just as easily (and economically), a high-low flow alarm. Or a flow totalizer. Or a combination of any of these.

When used as a simple flow indicator, the Full-View offers another kind of adaptability. Suppose there's a change in capacity requirements after installation. No problem. Just by turning the float head around you can increase or decrease the flow range anywhere from 25% to 33%. Substitute a heavier or lighter float body, and you can raise or lower capacity a full 100%. Without disturbing calibration.

And you can do the job in a matter of minutes. The Full-View's side-plate, dowel-pin construction eliminates all alignment difficulties. It also makes the meter exceptionally rugged. And easy to maintain. In fact, it is probably the most sensible rotameter construction going. Why else would most of the "new" meter designs you see around be derivative of this idea, which Brooks developed fifteen years ago?

Our Bulletin 115 will give you technical data on the complete Full-View line. A word from you will put a copy in the mail.

BROOKS INSTRUMENT COMPANY, INC.
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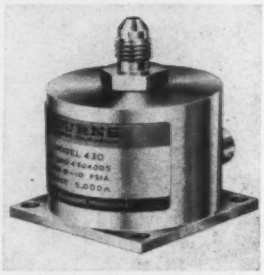
CIRCLE 124 ON READER-SERVICE CARD

TAPE PREPARATION SYSTEM

New Tapemaker typewriter-operated paper tape preparation system uses photoelectric encoding techniques which eliminate electrical and electromechanical encoding matrices, contacts, and switches. Consists of typewriter, photoelectric encoder, and paper tape punch. Prepares any code in 5-, 6-, 7- or 8-level tape.—*Invac Corp., Natick, Mass.*

CIRCLE 344 ON READER-SERVICE CARD

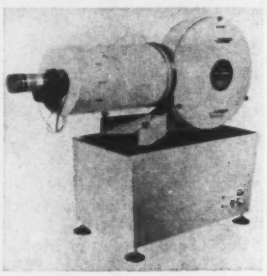
PRESSURE TRANSDUCERS



New Model 430 Absolute Pressure Transducer and companion Model 530 Differential Pressure Transducer feature individually calibrated pressure capsule that drives fully counterbalanced wiper arm which multiplies minute motion of pressure capsule to actuate potentiometer wiper. Bulletin.—*Bourns, Inc., Instrument Div., 6135 Magnolia Ave., Riverside, Calif.*

CIRCLE 345 ON READER-SERVICE CARD

SWEEPING-IMAGE RECORDER



New Model 339B Photo-Instrumentation System provides self-contained facilities to study high-speed transient events with velocities up to 200,000 ft/sec and with duration times down to 5 x 10^{-9} sec. System consists of sweeping-image camera, high-speed rotating mirror (200 to 2600 rps). Recording time is 131 μsec total and recording rate is 0.05 mm/μsec.—*Beckman & Whitley, Inc., San Carlos, Calif.*

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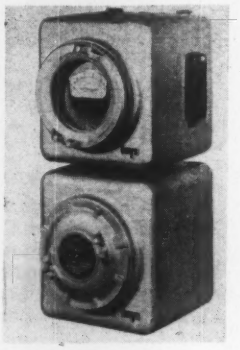
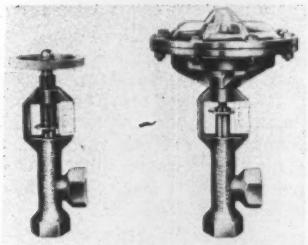
OXYGEN ANALYZER



New explosion-proof, low-range Oxygen Analyzer Model 632C for gas mixtures has dual-range design, affords precision analysis (±2%) under normal operation, is not affected by hydrogen or other hydrocarbons in background gas. Features built-in indicator; requires no external receiver; applies new paramagnetism concept.—*Hays Corp., 742 E. 8 St., Michigan City, Ind.*

CIRCLE 347 ON READER-SERVICE CARD

INDICATOR VALVE



New Indicator Valve with outside indicator shows orifice position which can be set and locked with optional locking handle. Operating threads are outside valve packing, preventing corrosion and galling. Made in sizes ⅛" to 4" with variety of standard tips and seats; pressure ratings to 10,000 psi working pressure; manual or air actuated.—*Flow Systems, Inc., 842 Production Pl., Newport Beach, Calif.*

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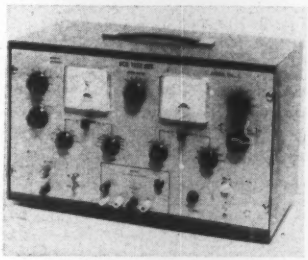
RECTIFIER TEST SET



New Model OA-1 Silicon Controlled Rectifier Test Set contains continuously-controllable power supply of up to 600 v and current supply up to 10 amp. Front panel connections are available for external gate bias voltages and for graphic display of voltage and current characteristics on external oscilloscopes.—*Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.*

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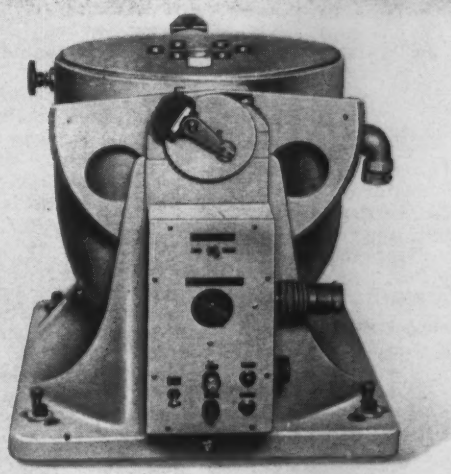


NEW TUMBLE RATE TEST STAND BY KEARFOTT

The Kearfott C05 6452 008 Tumble Rate Test Stand, is a highly precise unit used to test gyros and other devices requiring precise orientation or rotation. This unit features: rotary table locking arrangement to permit selection of 0°, 90°, 180°, and 270° static angular positions; ultra-precise tapered roller bearings to provide rugged, low-friction, accurate turntable mounting; 30 heavy-duty, low-noise slip rings to provide for signal and power transfer requirements; two-motor drive system to assure system stability and freedom from backlash, high gear reduction and large diameter bull gear mounted directly on table stand to enable high torque-to-voltage gradient, and leveling jacks, with hold-down bolts and azimuth adjusting locking device, to insure fine level and polar alignments.

TYPICAL DATA

Rotation Rates:	150° and 300° per hour
Table Rate Stability:	0.2%
Table Axis Wobble:	10 arc sec. (max.)
Tilting Range:	±90°
Table Surface:	flat to 0.0001 (or better as required)
Power Requirements:	115 VAC, 60 cps 1 phase at 15 watts; 28 VDC, 0.52 amp.
Dimensions:	2′ long x 2′ high x 2′ in diameter

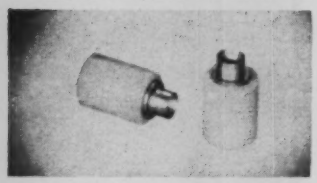
Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

CIRCLE 125 ON READER-SERVICE CARD

RECEPTACLE JACK



New printed-circuit Receptacle Jack SKT-111PC features Teflon body and spinover for vertical mounting on printed-circuit board. Accepts standard 0.080"-dia probe x 0.250" max.—*Sealectro Corp.*, 319 *Hoyt St., Mamaroneck, N. Y.*

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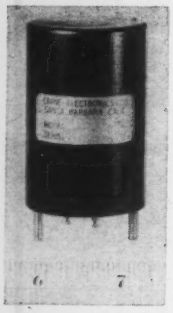
SOLID-STATE TIME DELAYS



New line of solid-state Timers for use from several seconds to 15 minutes feature reliability and compactness. Units have applications as sequencers, time delays, and automatic cycling switches. Standard operative voltage, 18 to 28 dc.—*Crane Electronics*, 4345 *Hollister Ave., Santa Barbara, Calif.*

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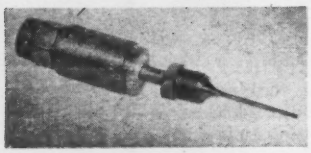
HI PRESS THERMOCOUPLE



New miniature Thermocouple Assemblies utilize ⅛" OD Trinox sheathed element which contains 30-gage thermocouple wire. Designed for installation in pipe line carrying polyethylene at high pressure. Hot junction is shaped like screwdriver tip.—*Trinity Equipment Corp., Cortland, N. Y.*

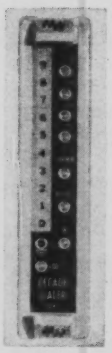
CIRCLE 354 ON READER-SERVICE CARD

MgO THERMOCOUPLES

New line of standard magnesium oxide Thermocouples includes several configurations, assortment of designs. Specs common to all units; 304 stainless steel sheath, stainless steel midget packing gland, grounded hot junctions, ⅛" OD sheath, thermocouple wire which meets ISA special limits of error.—*Conax Corp.*, 2300 *Walden Ave., Buffalo* 25, *N. Y.*

CIRCLE 351 ON READER-SERVICE CARD

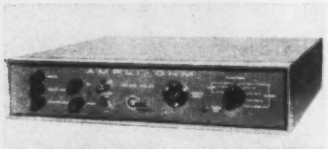
I-MC DECADE SCALER



New 1-Mc counter module Decade Scaler utilizes 8-4-2-1 binary code to count random serial pulses at any rate up to 1 Mc. Any number of units can be cascaded by front panel connectors to accomodate counts of any length; total count in all interconnected scalers is visually displayed on front panels in neon-lighted decimal digits. Bulletin.—*Harvey-Wells Electronics, Inc.*, 14 *Huron Dr., Natick, Mass.*

CIRCLE 353 ON READER-SERVICE CARD

AMPLI-OHM



New transistorized Ampli-Ohm AO-45, dual purpose industrial-electronics tool, features pre-amplifier capabilities and ability to convert voltmeter to ohmmeter; extends range of ordinary digital voltmeter into micro-volt ranges.—*Cubic Corp.*, 5575 *Kearny Villa Rd., San Diego* 11, *Calif.*

CIRCLE 355 ON READER-SERVICE CARD

3 new instruments for process control

MV-1 POTENTIOMETER

For testing, calibrating or servicing newest process controllers and amplifiers which convert millivolt input signals into proportional currents for control or telemetering. Combines all functions of precision potentiometer, millivolt source and milliammeter. 1/10 of 1% accuracy. 5⅜" x 8" x 5⁹⁄₁₆". 5½ lbs.

THE AUTOCOMP 1

For instrument checking and thermocouple measuring. Gives automatic cold junction compensation to devices used for measuring or controlling with thermocouples. Exclusive circuit employs thermistor network to match non-linear characteristics of thermocouples with output characteristics of bridge. 5⅜" x 8" x 5⁹⁄₁₆". 6 lbs.

RU-1 "RUN UP" SOURCE

Combination millivolt and milliampere "run up" source for instrument calibration. Checks newest process controllers and amplifiers. Current source furnished by two self-contained 90V batteries made to give stable, uniform outputs with cold cathode type voltage regulator tube. Self-contained. 5⅜" x 8" x 5⁹⁄₁₆". 10 lbs.

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TECHNIQUE

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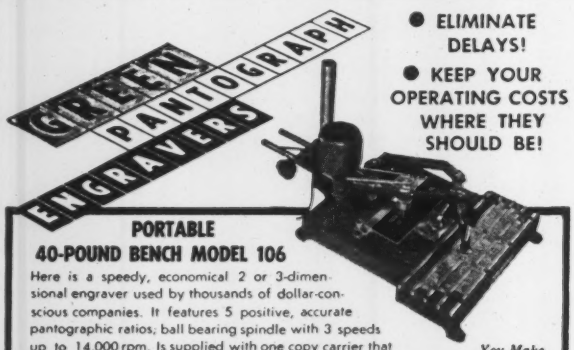

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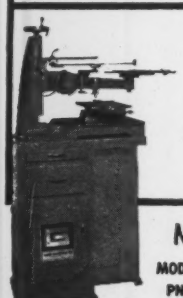
PORTABLE
40-POUND BENCH MODEL 106

Here is a speedy, economical 2 or 3-dimensional engraver used by thousands of dollar-conscious companies. It features 5 positive, accurate pantographic ratios; ball bearing spindle with 3 speeds up to 14,000 rpm. Is supplied with one copy carrier that accepts all standard master type sizes. Will actually work up to 10" by any width. Height of pantograph and position of cutter are continuously adjustable.

You Make Your Own Engraved Nameplates!



MODEL D-2 HEAVY-DUTY 2-DIMENSIONAL
Pantograph for milling, drilling and engraving.

Vertical adjustment of copy table automatic with Pantograph. Features: unobstructed on 3 sides to take large work; micrometer adjustment for depth of cut; ball bearing construction throughout; spindle speeds up to 26,000 rpm for engraving or machining; vertical range over 10"; ratios 2 to 1 to infinity — master copy area 26" x 10"

NEW
MODEL D2-201 PNEUMATIC ATTACHMENT

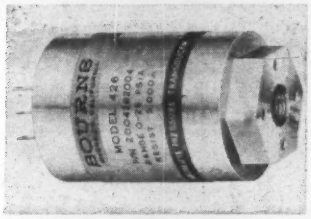
for use with Model D2 Pantograph Engraver to rapidly drill holes in printed circuits by tracing templates. Drills as many as 100 holes per minute. Equipped with foot switch; spindle air cylinder; regulating valve and pressure gauge; filter and oiler. It's ready to use as soon as it's attached to an air compressor

Write or call for full details and prices.

GREEN INSTRUMENT COMPANY, INC.
Dept 83 295 Vassar St.
Cambridge 39, Mass. Tel. ELiot 4-2989

CIRCLE 127 ON READER-SERVICE CARD

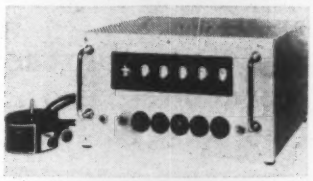
LOW PRESSURE TRANSDUCER



New low-pressure Transducer Model 426 features sealed stainless-steel case which houses Ni-Span-C capsule driving flexure linkage potentiometer wiper. Static error band accuracy is ±1.0%; range is 0-5 to 0-200 psia or psig; nominal resolution is 0.30 at 10,000 ohms. Bulletin.—*Bourns, Inc., Instrument Div., 6135 Magnolia Ave., Riverside, Calif.*

CIRCLE 356 ON READER-SERVICE CARD

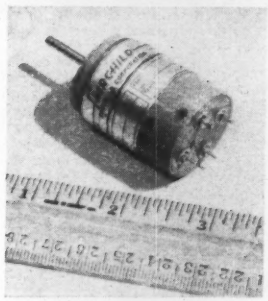
BIDIRECTIONAL COUNTER



New transistorized, compact Bidirectional Counter indicates true position while going through zero in either direction, e.g., when counting from +5 to −5, eliminating need for external reset to establish reference. Counter works with transducer, converts electrical impulses to Nixie tube visual readout and to digital type electrical readout; counting rate is 45,000 counts/sec.—*Hydro-Aire Co., Div. Crane Co., 300 Winona Blvd., Burbank, Calif.*

CIRCLE 357 ON READER-SERVICE CARD

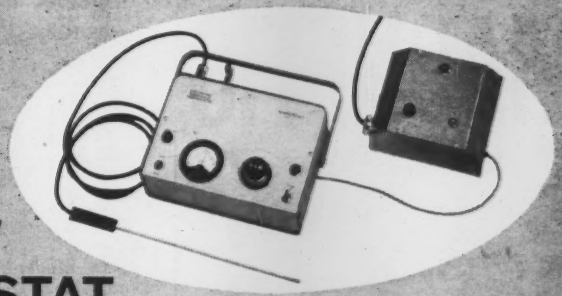
CONDUCTIVE PLASTIC POT



New "Fairite" line of Conductive Plastic Potentiometers utilizes continuous bulk track of conductive heat-resistant plastic co-molded with insulating base of same material. Continuous conductive track provides infinite resolution (less than 0.005°). Resistance range is 2-50 Kohms (±10%); standard linearity, 0.5%; power rating, 2 w at 20°C with 3-400 ppm negative temperature coefficient. —*Fairchild Controls Corp., 225 Park Ave., Hicksville, L. I., N. Y.*

CIRCLE 358 ON READER-SERVICE CARD

Outstanding precision... dependable time and work saver... new low price!



MANOSTAT
Electronic Resistance Thermometer

Direct temperature reading from −100°C to 900°C with 0.25°C accuracy!

Newly perfected design! Gives direct digital reading of temperature, from minus 100°C to plus 900°C, with an unusually high degree of accuracy: 0.25°C or 0.2% (whichever is greater). Eliminates the time-consuming calculations normally necessitated with high precision resistance thermometry. Each resistance bulb and bridge individually calibrated. Vacuum sealed platinum elements and leads in resistance bulb... hermetically sealed head... choice of stainless steel or quartz jacket. Plug-in controller accessory with 0.2°C reproducibility.

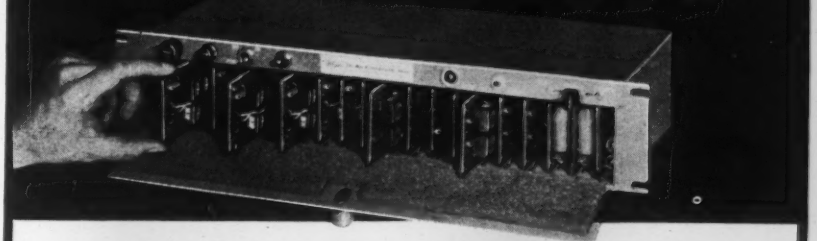
RT 1000 Electronic Resistance Thermometer individually calibrated but without Bulb or Controller **$975.00**
RT 1100 Stainless Steel Bulb, only **385.00**
RT 1200 Quartz Bulb, only. **385.00**
RT 1300 Temperature Controller, only **112.50**

See your local laboratory supply dealer.

MANOSTAT Corporation
26 N. Moore St., New York 13, N.Y.

CIRCLE 128 ON READER-SERVICE CARD

MAGNETIC STORAGE *plus* MAGNETIC LOGIC } **Unique Combination for highest Buffer Reliability**



Only DI-AN offers a combination of core memory and core logic that drastically reduces the semiconductor count in the circuitry required for control, address, drive, decoding, format conversion, and fullness control. Every one of DI-AN's 264 standard sequential-access buffer designs employs this exclusive feature. You will find, therefore, that these buffers are remarkably compact, significantly lower in cost, and far more reliable than ordinary equipment designed for equivalent performance.

DI-AN buffers can **do** more, too. The unique flexibility of magnetic logic, as applied by the most experienced digital-magnetic engineering staff in the field, can route more data, in **more complex formats and programs** — per dollar, per watt, and per cubic inch.

Write for details. Your name will automatically be added to the list that receives our newest "textbook" — a handbook on the theory and application of sequential-access buffers... off the press next month.

di an® **DI/AN CONTROLS, INC.**
944 Dorchester Ave., Boston 25, Mass. • AVenue 8-7700
magnetic digital/analog systems and components • TWX DORCH 1057

CIRCLE 129 ON READER-SERVICE CARD

SENSITIVE RESEARCH

MAGNETIC MEASUREMENTS

FLUXMETERS

Portable, .5% accurate DC fluxmeters provide a simplified method for the rapid measurement of magnetic flux density (B) and magnetic field strength (H).

The fluxmeter is a zero torque movement with indications based on flux linkage changes in an external search coil. Deflection is proportional to total quantity of charge moved through coil and the instrument may therefore be applied as an integrator. Basic sensitivity is 10,000 maxwells per division for a 1 turn search coil. Sensitivity is proportional to number of turns on the search coil.

Model FM (Ranges: x1/x3/x10/x30/x100) Price $310.00
Model FS (Single range) Price $215.00

TEST SETS

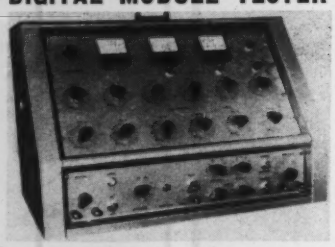
Model MAT does magnetic testing in conformance with methods prescribed by the ASTM. Specifically designed for 1) the determination of magnetization curves and hysteresis loops; 2) measurement of core loss using Epstein specimens, ring cores or E and I cores; 3) measurement of DC flux density or magnetic field strength; 4) measurement of AC permeability. Price $2,775.00

Model COL provides the user with a high accuracy method of measuring AC core loss and exciting current. Price $1,675.00

SENSITIVE RESEARCH INSTRUMENT CORPORATION
NEW ROCHELLE, N.Y

CIRCLE 130 ON READER-SERVICE CARD

DIGITAL MODULE TESTER



New Model DH-65 Digital Module Tester provides appropriate inputs (power and signal) and loads (resistive and capacitive) for complete monitoring operation of Cubic modules. Any two module pins can be monitored simultaneously.—*Cubic Corp., 5575 Kearny Villa Rd., San Diego 11, Calif.*

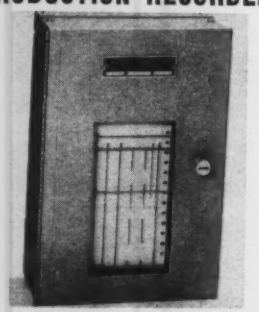
CIRCLE 359 ON READER-SERVICE CARD

TWO-CHANNEL DIRECT WRITER

New Sanborn 296 2-channel direct writing Oscillograph accepts any of Series 350 interchangeable preamplifiers. Readout recording by heating stylii on rectangular-coordinate Permapaper® charts with 50-mm channels. Basic sensitivity is 0.1 v/mm, frequency response to 125 cps within 3 db at 10 mm peak-to-peak amplitudes.—*Sanborn Co., Industrial Div., 175 Wyman St., Waltham 54, Mass.*

CIRCLE 360 ON READER-SERVICE CARD

PRODUCTION RECORDER



New Model OR-4 Electric Tachometer Operation Recorder uses special waxed charts driven by timing motor, records operating and down time of up to 10 machines simultaneously. Stationary heating element for each channel melts small portion of wax. —*Electric Tachometer Corp., 68 and Upland Sts., Phila. 42, Pa.*

CIRCLE 361 ON READER-SERVICE CARD

MINIATURE COAXIAL CABLE

COAXITUBE

FOR MISSILES
ELECTRONICS
AUTOMATION

SEAMLESS METAL TUBE...
SOLID DIELECTRIC...
SOLID INNER CONDUCTOR

Widely accepted for its performance-proved characteristics over a wide range of applications.

COAXITUBE in Electronics assures lower attenuation and a minimum of false signal pick-up... is electrically equivalent to all RG/U cables.

COAXITUBE in electromechanics guarantees complete weather-proofing with minimum weight.

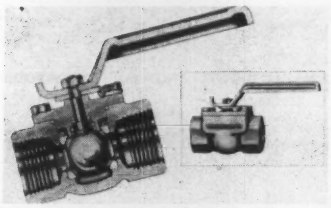
The center conductor is a solid or stranded copper wire, dielectric may be teflon or polyethylene. Outer conductor may be copper, aluminum or other non-ferrous alloy to meet requirements of weight, tensile strength or fatigue factors.

COAXITUBE is available in straight random lengths or coils to 40 feet... some in coils to 200 feet. It can also be furnished straightened, cut, stripped and formed in accordance with your sketch or drawing. Write for full technical details to—

PRECISION TUBE COMPANY, INC.
North Wales, Pa.

CIRCLE 131 ON READER-SERVICE CARD

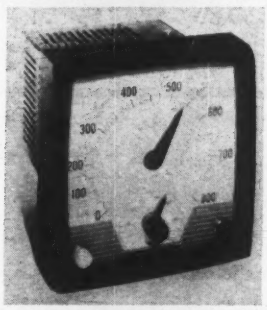
BALL VALVE



New Ball Valve of Type 316 stainless steel is for corrosive fluids and gases features of this new ball valve is its precision construction, precision molded and machined Teflon seats, top-entry design, self-aligning ball, straight-through flow, and leak-proof performance. Available in ¼" to 2" sizes.—*Lunkenheimer Co., Beekman St. at Waverly Ave., Cincinnati* 14, *Ohio.*

CIRCLE 362 ON READER-SERVICE CARD

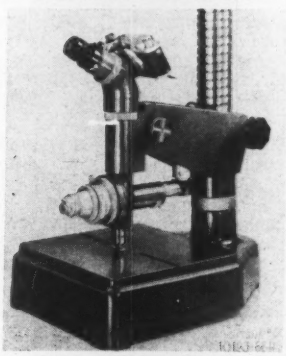
TEMPERATURE CONTROLLER



New 6000-A Series Indicating Temperature Controllers utilize precision Wheatstone bridge circuit with choice of 4 control modes from on-off through proportional and 3-position operation, and fail-safe resistance sensing element. Ranges: —300° to 2000°F.—*Electronic Processing Corp.*, 436 *Bryant St., San Francisco, Calif.*

CIRCLE 363 ON READER-SERVICE CARD

SURFACE TESTER

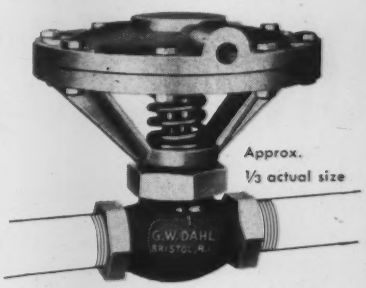


New Leitz Light Wave Surface Tester, Interference Microscope for checking highly finished surfaces, determines smoothness of surface finish interferometrically without making actual contact with surface under test. Employs Michelson beam splitter method.—*Opto-Metric Tools, Inc.*, 137 *Varick St., New York* 13, *N. Y.*

CIRCLE 364 ON READER-SERVICE CARD

G. W. DAHL • G. W. DAHL • G. W. DAHL • G. W. DAHL • G. W. DAHL

MINIATURE CONTROL VALVES REDUCE SPACE, WEIGHT, COSTS!



Dahl BANTAM Control Valve, Model 2020 . . . for on-off, quick-opening, or moderate throttling control . . . features excellent flow characteristics, low hysteresis, and fast response. Optional plug trims determine type of control.

Rated for 150 psi steam or 300 psi liquids and gases, the highly compact 2020 series offers choice of 8, 15, or 50 square-inch reverse or direct-acting, diaphragm operators. Connections in cast globe body range from ¼" to 2" N.P.T. Teflon packing eliminates frequent adjustment, reduces maintenance. Maximum C_v is 40.0; seat areas up to 3.1 sq. in.; ⅝" lift.

Similar series include valves with reverse-acting plugs held closed by spring compression and three-way styles for diverting, blending or selecting. Request Catalog B-1 for complete data. Write G. W. Dahl Co., Inc., 82 Tupelo Street, Bristol, Rhode Island.

G. W. DAHL CO., INC.

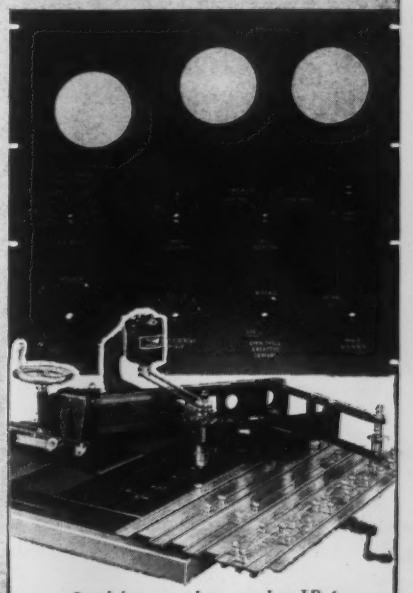
SPECIALISTS IN COMPACT VALVES AND CONTROLS

G. W. DAHL • G. W. DAHL • G. W. DAHL • G. W. DAHL • G. W. DAHL

CIRCLE 132 ON READER-SERVICE CARD

any size panels

engraved in your own plant



Engrave 1-inch nameplates or 6-foot panels by unskilled labor.

Spindle covers 18¼" x 6" in one set-up — more than any other machine of its kind.

Bench type model I-R—$685.

Send for complete catalog JR-4 illustrating other models from $325 up

new hermes ENGRAVING MACHINE CORP.

154 WEST 14th STREET, NEW YORK 11, N.Y. IN CANADA: 359 St. James Street West, Montreal, P.Q.

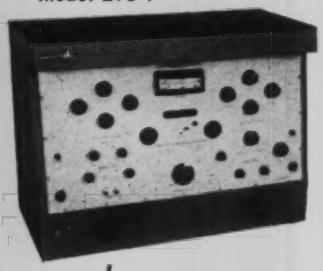
CIRCLE 133 ON READER-SERVICE CARD

SENSITIVE RESEARCH

CONSOLES

CALIBRATION

Model LTC-1



The *only* AC and DC calibration console to offer these advantages!

- **Accuracy:** ±.05% of reading
- **Frequency** Response: DC to 25 kc.
- **Current** Range: 1 ma. to 11.11 amps
- **Voltage** Range: .5 v. to 1111 v.
- **Readout** directly in "% Error."
- **Thermocouple** Overload Protection
- **Self-contained** for one man operation.

Price $5,560.00

Model LTCA-1 calibration console for high speed thermal operation. Specs similar to model LTC-1.
Price $4,450.00

Model LTA-1 console employs Hermach-type thermal transfer for potentiometric readout.
Price $2,750.00

INSTRUMENTS

Model RFVC

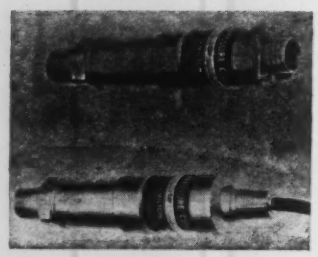
RADIO FREQUENCY CALIBRATOR for the certification of VTVM's from DC to 10 mc. Accuracy ±.3% of full scale; ±.2% maximum frequency influence. Ranges .01/.1/1/3 V. Responds to true RMS. Completely "Self Checking" against an internal reference source Diamond Pivoted, of course!

Price $840.00

SENSITIVE RESEARCH
INSTRUMENT CORPORATION
NEW ROCHELLE, N. Y

CIRCLE 134 ON READER-SERVICE CARD

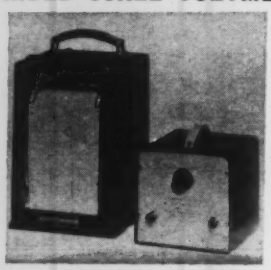
PRESSURE CELL



New general-purpose Pressure Cell features SR-4 foil strain gages, fully active four-arm Wheatstone bridge, direct bonding of gages to pressure-sensing element, and accessible external compensating resistors. Calibrated to 0.15% accuracy. Available in eleven capacities from 0-100 psi through 0-10,000 psi.—*Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., 42 Fourth Ave., Waltham 54, Mass.*

CIRCLE 365 ON READER-SERVICE CARD

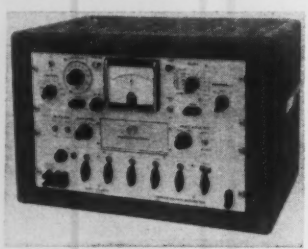
EXPANDED SCALE VOLTMETER



New expanded-scale Recording Voltmeter monitors voltage fluctuations using no tubes or transistors. Responds fully to 100-msec pulse, compared with approx 1 sec for dynamometer-type or 0.5 sec for rectifier-type. Sensitivity is down to 0.25 v in 120-v system.—*Brenner-Fiedler & Assoc., Inc., 7563 Melrose Ave., Los Angeles 46, Calif.*

CIRCLE 366 ON READER-SERVICE CARD

VOLTAGE RATIOMETER



New Model 551 Complex Voltage Ratiometer makes precision a-c measurements in magnitude and phase angle, as well as in-phase and quadrature components. Has inductive divider (RB-504 Radio Box) with inherent 1-ppm accuracy for ratio reference and Model VM-204 three-frequency phase-angle voltmeter as null detector.—*North Atlantic Industries, Inc., Terminal Dr., Plainview, L. I., N. Y.*

CIRCLE 367 ON READER-SERVICE CARD

Genisco

apd*

ANALOG TO PULSE DURATION INSTRUMENTATION

HERE'S THE FIRST SMALL COMPLETE DATA-ACQUISITION SYSTEM

The new low-cost Genisco APD Data Acquisition system is a complete and compact solid-state packaged system designed to meet a wide range of instrumentation requirements. You can use it to read out thermocouples, resistance thermometers, strain-gage transducers or any other DC voltage low-impedance sensors. Modular plug-in board design allows great flexibility—one chassis can provide a complete 20-channel system.

Data is sampled at 20 samples per second; repeatability is 0.1% of full scale. Output can be shown or recorded directly in engineering units with sign indication and channel identification. Readout can be converted to punch tape, magnetic tape, typewriter or other storage medium.

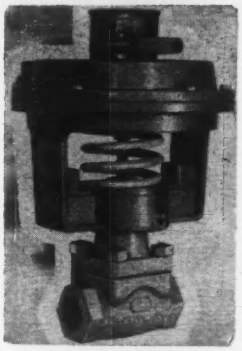
The new Genisco APD requires low power and is ideal for portable, laboratory, or field use. Call or write today for prices and complete details.

*Patent Applied For

Genisco
INCORPORATED
2233 Federal Ave., Los Angeles 64, California

CIRCLE 135 ON READER-SERVICE CARD

LOW FLOW CONTROL VALVES



New 1400-Series compact Valves for regulating flow of small streams of air, water, steam, or chemical solutions includes low-cost, lightweight diaphragm-actuated model, high-performance diaphragm model, ultra-low-flow model, and two models with electric actuators using low or line voltage, offering two-position, floating or proportional control and stroking speeds as low as 7.5 sec. Available in ½", ¾" and 1" sizes with wide selection of reduced inner ports to C_v's from 0.025 to 11.—*Minneapolis-Honeywell Regulator Co., Valve Div., Fort Washington, Pa.*

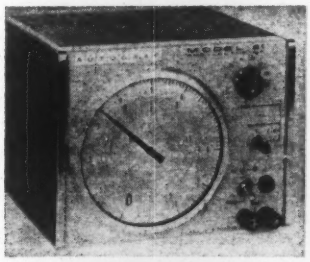
CIRCLE 368 ON READER-SERVICE CARD

LEAK-TIGHT FITTING

New Swagelok KayZee Tube Fitting consists of brass-tube fitting body with Zytel ferrules and brass knurled nut for finger-tight, leak-proof assembly with polyethylene tubing for vacuum or pressure applications. Stock sizes ¼" and ⅜" OD tubing.—*Crawford Fitting Co., 884 E. 140th St., Cleveland 10, Ohio.*

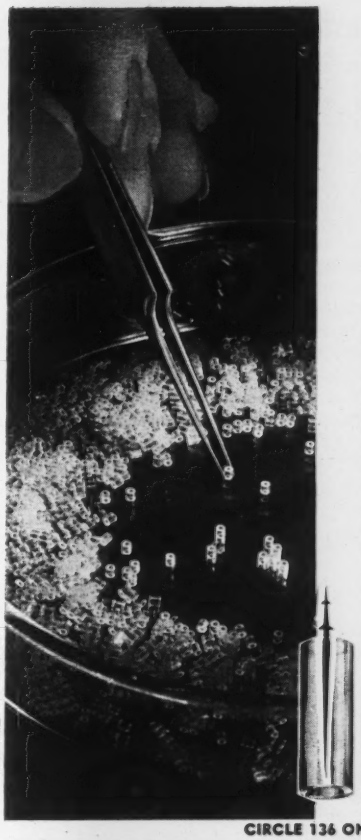
CIRCLE 369 ON READER-SERVICE CARD

TRUE RMS VOLTMETER



New high-accuracy Autograf Model 21 RMS Voltmeter, multi-range, servo-operated instrument, covers voltage range 10 mv to 200 v rms full scale in 14 steps; operates from 5 cps to 100 kc with sinusoidal input. Accuracy, measured at 1 kc from first 10% of scale to full scale, is ±0.25%.—*F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena, Calif.*

CIRCLE 370 ON READER-SERVICE CARD



Got a glass problem? T.H. GARNER COMPANY IS DIFFERENT

We machine-draw tubing to your new dimensions and ship in a matter of hours.

If your problem can be resolved by new dimensions (O.D., I.D., length) or tolerances, call us today for service.

Our own glass tube drawing facilities running 24 hours a day give us the flexibility to handle a variety of changes quickly.

Your job is immediately assigned to one of several drawing and cutting systems guaranteed to produce the best quality and yields.

Garner capacity for millions of parts weekly is built on routine manufacturing to many dimensions in many glass types. Our quality is based on in-plant designed equipment. We can give you tolerance control 366 days a year.

Reliability? Our rejection rate on over a billion parts shipped is less than ¼ of 1% by actual count.

Send for Complete Data.

T.H. GARNER COMPANY

177 S. Indian Hill Blvd., Claremont, Calif.
NAtional 6-3526

Serving the electronic and instrumentation fields since 1953

CIRCLE 136 ON READER-SERVICE CARD

FIRST AND ONLY

RECORDING pH METER

Permanent pH Record • Simple to Operate • Adaptable • No Ink

A pH meter and strip chart recorder in one. Line operated. Continuously indicating. Can record continuously for 31 days at one inch per hour. With manual temperature compensator. Write for Bulletin No. 3R.

Price $245.00 complete, with Analytical protected pH probe unit

ANALYTICAL MEASUREMENTS, INC.

585 Main Street
Chatham, New Jersey

CIRCLE 137 ON READER-SERVICE CARD

INSTRULAB'S

Temperature Compensated

evenvolt

Constant Voltage Unit

Replaces Batteries and All Standardizing Components Including Standard Cell In

POTENTIOMETERS

• CONTROLLERS • INDICATORS • RECORDERS

Mfg. By **INSTRULAB, INC.**

1205 Lamar Street
Dayton 4, Ohio
Phone BA 3-2241

Outstanding FEATURES

- **Eliminates** batteries ...errors due to battery exhaustion
- **Reliable** construction...from quality components, long, trouble-free service
- **A Precise** voltage regulator . . . max. ±.04% for ±20% voltage variation
- **Quickly Installed**... Fits present instrument battery space.
- **No Tubes** to replace

CIRCLE 138 ON READER-SERVICE CARD

SENSITIVE RESEARCH

POCKET POTENTIOMETER

new! .05% accurate Miniature DC Potentiometer!

Model PC *

PocketPot

Precision DC measuring potentiometer with self-contained galvanometer and battery operated standardization circuit. Direct "in line" readout. Additional voltage and current ranges can be obtained by using it in combination with the Model PC-S, a switch controlled, .05% accurate "plug in" unit of the same size.

Additional Specifications

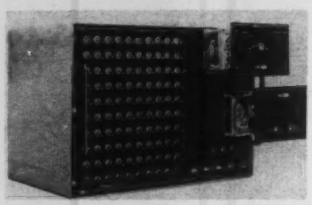
ACCURACY: ± .05% of reading or ± .5 mv., whichever is greater.
RANGES: 0–5.100 v; when used with PC-S, 0–500 v. and 0–1 amp.
RESOLUTION: Continuous. 1 mv. divisions on slide wire.
SENSITIVITY: Infinite resistance at null. When used with PC-S, 2,000 Ω/v.
SIZE: 9" x 4¼" x 1¾".
WEIGHT: 3 lbs.
PRICE: Model PC, $450.00; Model PC-S, $175.00.

*Copyright U.S.A. Patent Applied for

SENSITIVE RESEARCH INSTRUMENT CORPORATION
NEW ROCHELLE, N. Y

CIRCLE 139 ON READER-SERVICE CARD

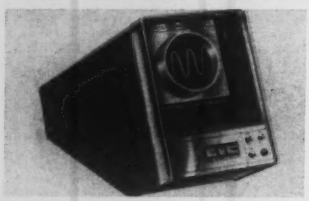
DIGITAL PATTERN GENERATOR



New Digital Pattern Generator, transistorized test instrument, provides adjustable time division pulse pattern of nearly any description. Output wave form can be varied in number of pulses, amplitude of pulse, pulse duration, and duration of positive pulses with respect to negative pulses.—*Magnavox Co., Government and Industrial Div., Urbana, Ill.*

CIRCLE 371 ON READER-SERVICE CARD

AUTOMATIC OSCILLOSCOPE



New solid-state 10-Mc fully-automatic Oscilloscope displays perfectly sized and positioned picture of waveform under test regardless of input voltage magnitude, frequency, or d-c offset. Uses automatic sweep speed, sensitivity, and positioning. Has 5" CRT.—*California Instructments Corp., 3511 Midway Dr., San Diego 10, Calif.*

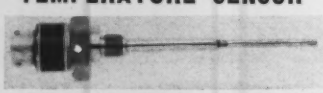
CIRCLE 372 ON READER-SERVICE CARD

RESISTOR TUBING

New Restrictor Tubing with certification covering 100% testing of tubing to meet flow specifications is capped at both ends with heat-sealed plastic. Sizes 0.072" OD x 0.026" ID to 0.172" OD x 0.115" ID.—*Kensico Tube Co. Div., Robinson Technical Products, Inc., Mt. Kisco, N. Y.*

CIRCLE 373 ON READER-SERVICE CARD

TEMPERATURE SENSOR



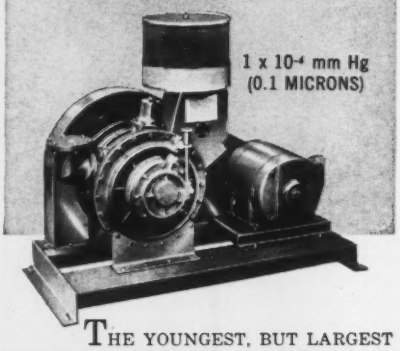
New immersion-type platinum Resistance Temperature Sensor Model 176 has 0.2-sec time constant temperature range −435° to +500°F.—*Rosemount Eng. Co., 4900 W. 78 St., Minneapolis 24, Minn.*

CIRCLE 374 ON READER-SERVICE CARD

NEW! HIGH CAPACITY!

TWO-STAGE WELCH "DUO-SEAL" VACUUM PUMP No. 1398

50 CFM (1400 LITERS/MINUTE)



THE YOUNGEST, BUT LARGEST MEMBER of the Welch family of "Duo-Seal" oil sealed rotary vacuum pumps makes its appearance as the No. 1398. This new pump offers very high capacity and excellent ultimate vacuum characteristics with no sacrifice of long life, low maintenance, freedom from vibration and minimum noise level. These features have long made Welch "Duo-Seal" pumps the most widely used of all rotary vacuum pumps.

1398's, like all Welch "Duo-Seal" Pumps, are thoroughly run-in at the factory and tested until they exceed their vacuum guarantee.

The new 1398 is highly recommended for all industrial and laboratory applications requiring high pumping capacities and low pressures. Typical uses are electron tube evacuation, vacuum distillation, dehydration, reduction, sublimation, metallizing, metal processing, leak detection, hermetic sealing and back-filling, impregnation and general scientific studies.

IMPORTANT FEATURES:

- High pumping speed — 50 CFM (1400 liters/minute)
- Low ultimate pressure — 1 x 10⁻⁴ mm Hg (McLeod)
- Quiet, vibration-free operation
- Compact, rugged design
- Air-cooled
- Vented Exhaust Valve
- Flanged, O-Ring-Sealed Intake Port
- Totally Enclosed Belt Guard
- Air Intake Screen
- Exhaust Filter
- Trouble-free, low maintenance

WELCH "DUO-SEAL" PUMPS ARE CARRIED IN STOCK BY AUTHORIZED DEALERS.

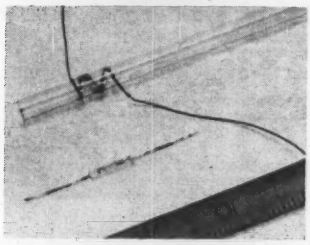
Welch Duo-Seal Vacuum Pumps are manufactured in wide variety of capacities and ultimate vacuum characteristics. They range in capacities from 21 to 1400 liters/minute and ultimates from 2 x 10⁻³ mm Hg down to 1 x 10⁻⁴ mm Hg.

WRITE FOR DUO-SEAL CATALOG and BULLETIN 1398 for full description and prices.

SINCE 1880 THE WELCH SCIENTIFIC CO.
foremost manufacturers of scientific equipment
1509 N. Sedgwick St. • Chicago 10, Ill.

CIRCLE 140 ON READER-SERVICE CARD

SEMICONDUCTOR STRAIN GAGES

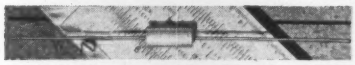


New solid-state Strain Gages provide higher working strain levels, increased flexibility, better handling characteristics. Resistance ranges: 120 to 5,000 ohms. Bulletin.—*Kulite-Bytrex Corp., 50 Hunt St., Newton 58, Mass.*

CIRCLE 375 ON READER-SERVICE CARD

MINIATURE INDUCTOR

New addition extends Wee-Ductor values from 0.1 to 56,000 μhenries with less than 2% coupling when assembled side by side. Meeting MIL-C-15305A requirements, it measures only 0.160" diameter x 0.375" long.—*Essex Electronics, Div. of Nytronics, Inc., 550 Springfield Ave., Berkeley Heights, N. J.*



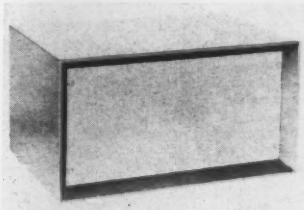
CIRCLE 376 ON READER-SERVICE CARD

DRIVER AMPLIFIER

New solid-state chopper-stabilized Model AD123 Unity Gain Driver Amplifier has bandwidth less than 3 db down dc to 80 kc; features double level isolation; drives galvanometers, servo valves, etc. with low impedance load requirements. Output capability is ±10 v at ±100 ma; gain is 1.00; gain accuracy within 1% at dc. Output impedance is less than 1 ohm to 1 kc and less than 20 ohms to 30 kc. —*Computer Engineering Assocs., 350 N. Halstead, Pasadena, Calif.*

CIRCLE 377 ON READER-SERVICE CARD

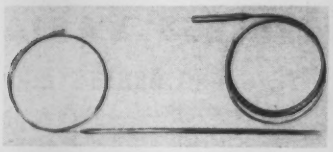
CABINET



New Shadow Cabinet has removable front and rear panels, as well as bottom, for installation or servicing. Made in four sizes.—*Bud Radio, Inc., 2118 E. 55 St., Cleveland 3, Ohio.*

CIRCLE 378 ON READER-SERVICE CARD

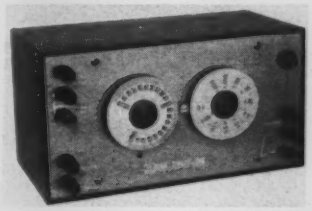
CAPILLARY TUBE AND BULB



New one-piece Capillary Tube and Bulb Assembly is made to specifications but range offered includes bulb sizes up to ⅜" OD max with capillary tubing of 0.010" ID minimum.—*Kensico Tube Co. Div., Robinson Technical Products, Inc., Mt. Kisco, N. Y.*

CIRCLE 379 ON READER-SERVICE CARD

VOLTAGE CALIBRATOR



New SV-194 Voltage Calibrator checks calibration adjustments of accurate d-c voltmeters to within 0.01%. Output voltages 0.05-1,000 are provided.—*Electro Scientific Industries (formerly Electro Measurements), 7524 SW Macadam Ave., Portland 19, Ore.*

CIRCLE 380 ON READER-SERVICE CARD

A. D. JONES OPTICAL WORKS

2400 MASSACHUSETTS AVENUE
CAMBRIDGE 40 MASSACHUSETTS
TRowbridge 6-3368—3369

People usually associate Optics with glass only. The following materials, successfully processed here by sawing, grinding and polishing or drilling are of value to designers, engineers and manufacturers. Most materials are supplied by our customers for their orders.

ALUMINA
ALUMINUM
ARSENIC TRISULPHIDE
BARIUM TITANATE
BRASS
CALCIUM TUNGSTATE
CARBORUNDUM
CERAMIC
COBALT FERRITE
COPPER
CORNING 707
CORNING 7052
FERRITE
FERROX
FLUORIDE, CALCIUM
FLUORIDE, LITHIUM
GALLIUM ANTIMONIDE
GARNET
GERMANIUM
GOLD
INDIUM ANTIMONITE
INDIUM PHOSPHIDE
INDOX
IRON SINGLE CRYSTAL
LITHIUM FERRITE
MAGNESIUM STANIDE
NICKEL OXIDE
NIOBIUM
PLATINUM
POTASSIUM BROMIDE
PYREX
QUARTZ, CRYSTAL
QUARTZ, FUSED
SAPPHIRE
SILICON
SODIUM CHLORIDE
STEEL
STRONTIUM TITANATE
TEFLON
TITANIUM DIOXIDE
VYCOR
X-RAY LEAD GLASS
VANADIUM

CIRCLE 141 ON READER-SERVICE CARD

Precision Dials

Ackerman Engravers Stock Dials range from 2 to 6 inches in diameter, and are engraved in various configurations up to 360 graduations, clockwise and counter-clockwise. Ring dials, drum dials, verniers, knobs, and hubs are also available. A number of finishes all of which meet military specifications can be had.

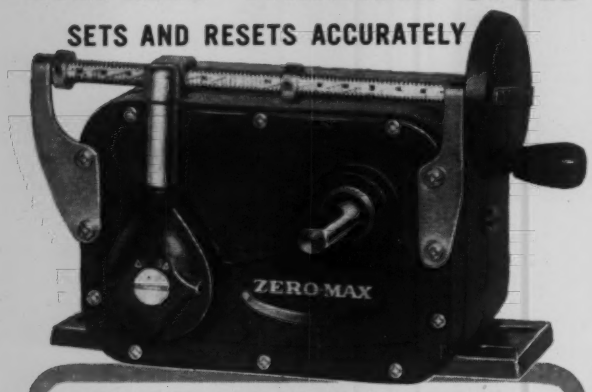
Whatever your Dial specification, stock or custom consult Ackerman Engravers.

ACKERMAN ENGRAVERS, INC.
43-22 36 St., Long Island City 1, N.Y.

CIRCLE 142 ON READER-SERVICE CARD

STEPLESS VARIABLE SPEED

SETS AND RESETS ACCURATELY



PRECISION CONTROL

This Zero-Max screw control gives exact speed settings. It is one of many options from the standard lever type control.

Zero-Max drives deliver constant torque, are truly stepless—zero to maximum—available with instant reverse and neutral. They are low cost, small in size but big in power and performance. Over 30 basic fhp models (1/15 to 3/4 hp) carry torque ratings of 3 to 450 in. lbs. and speed ranges to 0 to 1200 rpm. Drives come with or without motors and gearheads.

Send for free catalog and name of your nearest representative.

The **ZERO-MAX**® *Company*

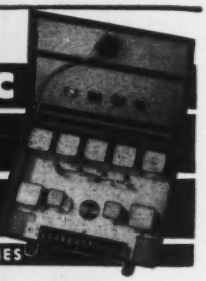
2885 Harriet Avenue South
Minneapolis 8, Minn.
TAylor 7-5521

CIRCLE 143 ON READER-SERVICE CARD

Synchro-Start

FULL AUTOMATIC ENGINE CONTROLS

FOR GASOLINE DIESEL & GAS ENGINES



Synchro-Start's new protective engine controls have been designed, for the starting and stopping of engines from remote pilot devices, such as pressure switches, float switches, power failure relays, etc., and are completely automatic in operation.

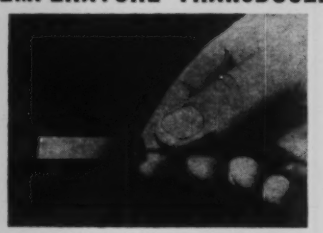
These dependable controls are encased in a steel, dust proof cabinet, and now feature enclosed PLUG-IN RELAYS as well as OVERLOAD BREAKERS. The plug-in relays simplify what little field maintenance that may have been required in older models, while the overload breakers eliminate the necessity of replacing fuses.

In designing this unit we have used the same high quality materials and workmanship that our customers have come to expect throughout Synchro-Start's 27 years of manufacturing engine controls.

SYNCHRO-START PRODUCTS, INC.
Since 1932
8151 NORTH RIDGEWAY AVENUE • SKOKIE, ILLINOIS

CIRCLE 144 ON READER-SERVICE CARD

TEMPERATURE TRANSDUCER



New Model 2508 high-temperature, surface, resistance-temperature transducer uses platinum element with resistance of 100 ohms ±1% at 77°F, provides continuous operation at temperatures as high as 2000°F.—*Winsco Instruments & Controls Co., 11789 W. Pico Blvd., Los Angeles 64, Calif.*

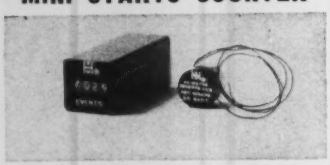
CIRCLE 381 ON READER-SERVICE CARD

DATA READOUT

New Series 160000 rear-projection Data Readout uses new lens system for display on almost full viewing screen face. Affords more than 1½ sq in of usable viewing area compared with ¾ sq in of conventional models.—*Industrial Electronic Engineers, Inc., 5528 Vineland Ave., North Hollywood, Calif.*

CIRCLE 382 ON READER-SERVICE CARD

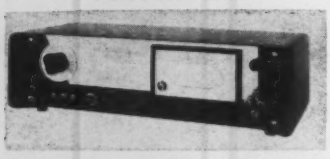
MINI STARTS COUNTER



New ¾-oz Starts or Events Counter (1½" sq x 1⅝") operates from 28-vdc source, employs four-digit drum counter with range of 9999 events or starts. Driven by single-phase hysteresis-type micro-miniature motor, ⅜" dia by 9/32", with torque of 0.00005 in-oz.—*A. W. Haydon Co., Waterbury, Conn.*

CIRCLE 383 ON READER-SERVICE CARD

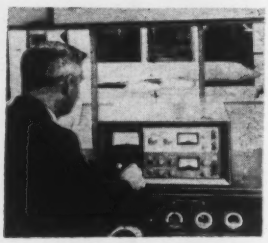
AC/DC CONVERTER-VOLTMETER



New Model HVC-30 AC/DC Converter-Voltmeter provides 25-μv resolution on lowest scale with only 0.5% ripple down to 5 cps. Also can be used as 1% a-c vacuum tube voltmeter. Input ranges 10 mv to 300 v full scale.—*Houston Instrument Corp., Box 22234, Houston 27, Tex.*

CIRCLE 384 ON READER-SERVICE CARD

DYNAMIC ANALYZER



New Dynamic Analyzer, inherently frequency-tuned band pass filter, has center frequency positioned automatically and continuously by external frequency such as tachometer or oscillator. Operation does not depend on internal servo control or frequency-to-dc conversion. Technique allows use of extremely narrow band width filters.—*General Dynamics/Electronics, Information Technology Div., Box 2449, San Diego 12, Calif.*

CIRCLE 385 ON READER-SERVICE CARD

HEAT-SENSITIVE CHARTS

New heat-sensitive Recording Charts provide fine trace lines, outstanding dimensional stability, and high degree of resistance to abrasion. Sample on request.—*Graphic Controls Corp., 189 Van Rensselaer St., Buffalo 10, N. Y.*

CIRCLE 386 ON READER-SERVICE CARD

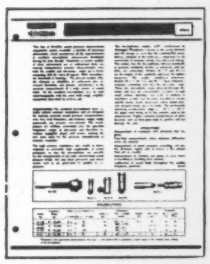
COVER WIDE FREQUENCY AND DYNAMIC RANGES

MORE THAN

10 KC AND

200 db

Massa A.D.P. (Ammonium Di-Hydrogen Phosphate) Sound Pressure Microphones provide reliable waveform reproductions of broad band sound such as generated by high intensity acoustic noise facilities. Frequency responses, which extend well into the ultrasonic range, make these instruments ideally suited for steady state high frequency work or with transients having extremely fast rise times. Compact in design, these microphones make excellent probe elements which fit into tiny circular openings and hard to reach spaces.



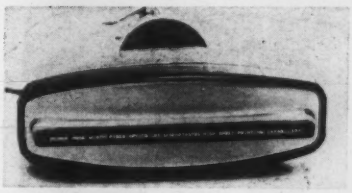
Each model presents near infinite acoustic impedance and makes accurate measurements over wide dynamic and frequency ranges under practically any acoustic environment. Choice of model depends on sensitivity, ultimate frequency range and available test space.

Write for Technical Bulletin SPM-5

MASSA
A DIVISION OF
COHU
ELECTRONICS, INC.
280 LINCOLN STREET
HINGHAM, MASSACHUSETTS

CIRCLE 145 ON READER-SERVICE CARD

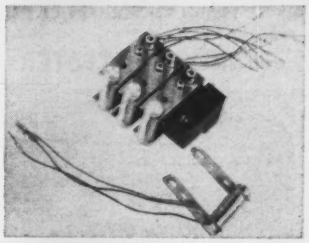
FIBER OPTICS BEAM TUBE



New Cathode Ray Tube utilizing Charactron® shaped-beam-tube method of character generation with full page-width fiber-optics-faceplate (8½" x ½") eliminates conventional lens systems and allows direct contact printing. Features high speed, high resolution.—*General Dynamics/Electronics, Information Technology Div., Box* 2449, *San Diego* 12, *Calif.*

CIRCLE 387 ON READER-SERVICE CARD

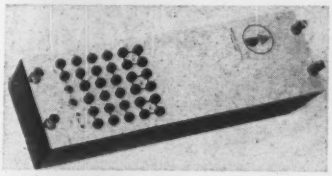
FLYING MAGNETIC HEADS



Nw Flying Magnetic Heads assure magnetic drum reliability; feature double-reed design for fail-safe operation, standard cylindrical heads, high resolution, increased pulse packing, track density. Series 2500 has up to 32 tracks/in; Series 1000, to 64 tracks/in.—*Bryant Computer Products Div., Ex-Cell-O Corp., Walled Lake, Mich.*

CIRCLE 388 ON READER-SERVICE CARD

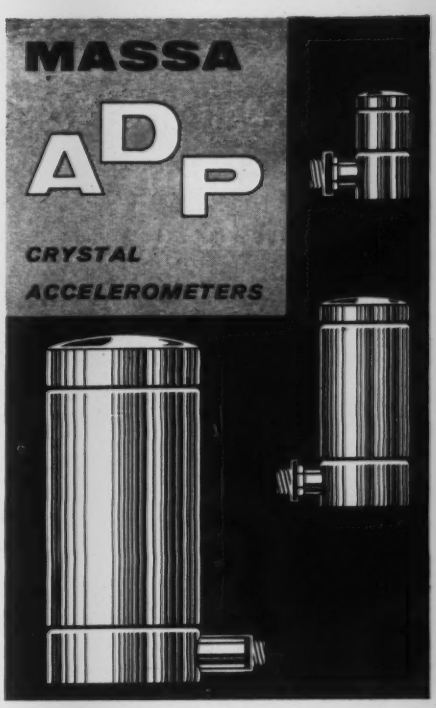
ANALOG MULTIPLIER



New Electronic Multiplier Model 160 features static accuracy of 0.15%, simplified circuit design, reduced cost. Standard on firms analog computers, they are available for expansion of other d-c analog systems operating between ± 100 v, or as independent units; offered as individual boards, and in 3-, 6-, and 20-unit chassis.—*Applied Dynamics, Inc.,* 2275 *Platt Rd., Ann Arbor, Mich.*

CIRCLE 389 ON READER-SERVICE CARD

For More Information on Products Listed Please Circle the Corresponding Number on the Readers-Service Card



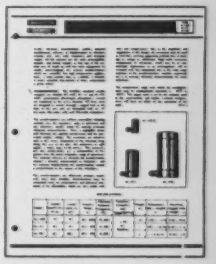
PRIMARY STANDARDS

NOW AVAILABLE FOR

ROUTINE TESTING

Primarily designed as precision standards, Massa A.D.P. (Ammonium Di-Hydrogen Phosphate) Crystal Accelerometers never need calibration. Their use in routine vibration measurements eliminates the acoustical accelerometer check prior to the actual test run. This means savings in calibration man-hours amounting to many times their purchase price. Many Massa Accelerometers have been doing this for as long as fifteen years.

Only Massa Accelerometers use the A.D.P. crystal. Precise manufacturing techniques make possible full realization of the uniformity, stability and reliability inherent in this exclusive material.



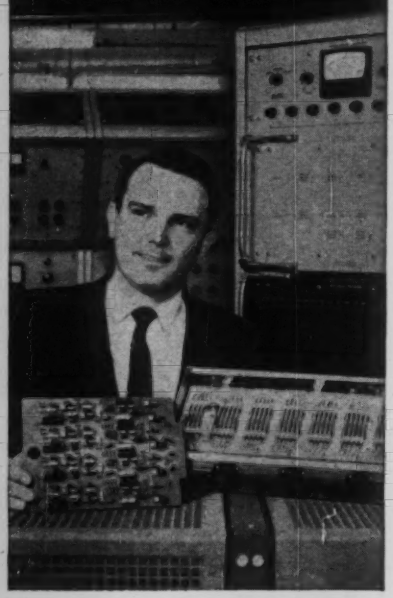
Write for Technical Bulletin, VM

MASSA
A DIVISION OF
COHU
ELECTRONICS, INC.
280 LINCOLN STREET
HINGHAM, MASSACHUSETTS

CIRCLE 146 ON READER-SERVICE CARD

NEW

MB Automatic Spectrum Equalizer



- *Speeds Up Random Vibration Testing*
- *Eliminates Costly Set-Up Time*

MB's New Automatic Spectrum Equalizer provides automatic compensation of "random motion" system. Saves time and money in environmental testing of missile components and systems. Simply set desired spectrum shape on graphic panel in terms of power density in db, and turn the level control. The fully automatic control system assures conformity between desired and actual spectra. Tests can be rerun at a later date with assurance of identical spectral content.

Other features include:

- High accuracy; employs 80 filters, each 25 cps wide, covering frequency range 15 cps to 2000 cps.
- Wide dynamic control range
- High stability; better than .008%/° C.
- Low distortion; less than 1.5%
- Special read-out to permit rapid analysis

For more information, send for Bulletin 129.

MB ELECTRONICS

A DIVISION OF TEXTRON ELECTRONICS, INC.
1103 State Street, New Haven 11, Conn.

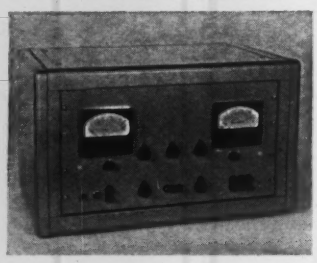
CIRCLE 147 ON READER-SERVICE CARD

DIGITAL TELEMETERING

New Type DL Digital Telemetering Equipment for simple applications such as telemetering of kilowatt-hours on electrical utility systems or positive displacement on pipelines has telephone relays and stepping switches, is suitable for operating with Visicode® supervisory control systems. Uses binary-coded decimal form by means of long and short pulses and spaces.—*Westinghouse Electric Corp., Box* 2099, *Pittsburgh* 30, *Pa.*

CIRCLE 390 ON READER-SERVICE CARD

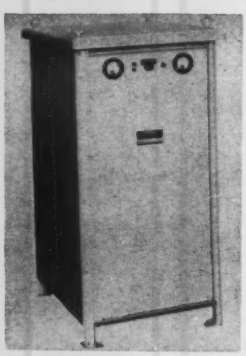
TRANSISTOR TESTER



New h-Parameter Testor quick tests the four "h" parameters of any signal transistor to 2% accuracy, over wide operating ranges, in either grounded base or grounded emitter configurations.—*Tenco Electronics, Inc.,* 108 *Cummington St., Boston* 15, *Mass.*

CIRCLE 391 ON READER-SERVICE CARD

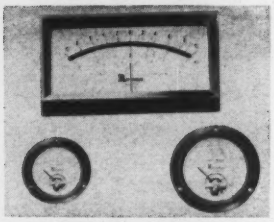
POWER SUPPLY CABINET



New Model "2C" power supply cabinet for capacities in the 12 to 45 kw range, meets shock and vibration requirements of category "D" per MIL-E-4970A. It is also weatherproof and suitable for outdoor use.—*Christie Electric Corp.,* 3410 *W.* 67*th St., Los Angeles* 43, *Calif.*

CIRCLE 392 ON READER-SERVICE CARD

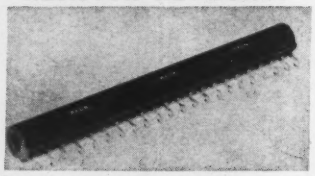
PANEL METERS



New Model 145 commercial panel meter achieves a scale length of over 4" in a meter measuring only 2¾" by 5". Models 25 and 35 meet all provisions of MIL-M-10304B.—*Rowan Controller Co.,* 30 *Bridge Ave., Red Bank, N. J.*

CIRCLE 393 ON READER-SERVICE CARD

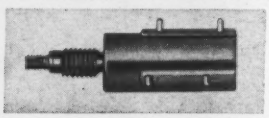
RESISTOR NETWORKS



New lug-type resistor networks $\frac{5}{16}$" diameter, are available in lengths up to 6" with a maximum of 13 resistors in the network.—*Reon Resistor Corporation,* 155 *Saw Mill River Rd., Yonkers, N. Y.*

CIRCLE 394 ON READER-SERVICE CARD

VARIABLE INDUCTORS



New encapsulated variable r.f. inductors, with single or bifilar windings meeting MIL-C-15305 are uncapsulated under vacuum to insure reliable operation even after prolonged immersion in water.—*Vanguard Electronics Co.,* 3384 *Motor Ave., Los Angeles* 34, *Calif.*

CIRCLE 395 ON READER-SERVICE CARD

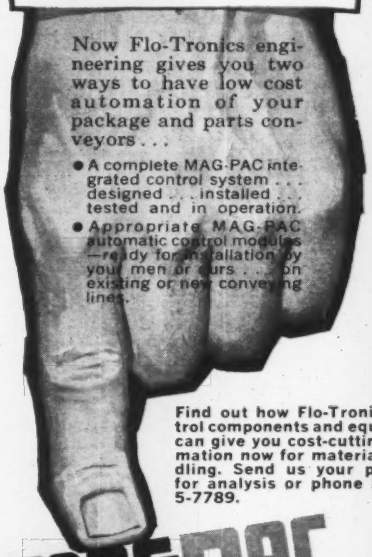
FIELD INTENSITY RECEIVER

New Model CFI microwave Field intensity receiver system is mobile, transistorized, calibrated field intensity instrument covering the 1 kmc to 10 kmc range. Besides the basic unit, it includes four RF tuning units, impulse calibrator, five antennas and a tripod. The basic receiver features a calibrated meter to indicate average, peak, slide-back peak and quasi-peak values on five scales: 1,000 μv,, db above 1 μv/mc (1mc bandwidth), db above 1μv/mc (5 mc bandwidth), 70 db relative, and 20 db linear.—*Polarad Electronics Corp.,* 43-20 34*th St., Long Island City* 1, *N. Y.*

CIRCLE 396 ON READER-SERVICE CARD

Put your finger on automation

FLO-tronically



Now Flo-Tronics engineering gives you two ways to have low cost automation of your package and parts conveyors . . .

- A complete MAG-PAC integrated control system . . . designed . . . installed . . . tested and in operation.
- Appropriate MAG-PAC automatic control modules —ready for installation by your men or ours . . . on existing or new conveying lines.

Find out how Flo-Tronics control components and equipment can give you cost-cutting automation now for materials handling. Send us your problem for analysis or phone FEderal 5-7789.

MAG-PAC MAGNETIC CONVEYOR CONTROLS

FLO-TRONICS, INC.

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CIRCLE 143 ON READER-SERVICE CARD

NEW NEW NEW NEW NEW NEW NEW NEW NEW

when it MELTS you know the *temperature!*

NEW *Markal* **THERMOMELT TEMPERATURE INDICATORS**

With Handy Adjustable Holder

The easy modern way to determine exact working temperatures!

Just mark or stroke the surface with THERMOMELT . . . when it reaches the desired temperature, the mark liquefies. There's no guesswork, no wasted time or material . . . THERMOMELT is the quick, precise way to determine heating temperatures. Accurate to within ±1%.

A Stik For Every Temperature from 113° F. to 2000° F.

SEND TODAY for free THERMOMELT literature and pellet sample (indicate temperature desired).

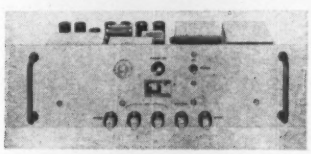
ALSO AVAILABLE IN LIQUIDS AND PELLETS for inaccessible or hard-to-measure applications. Wide range of temperatures.

Made by the Manufacturers of Markal Paintstik Markers and Protective Coatings.

MARKAL CO. 3080 West Carroll Avenue • Chicago 12, Illinois

CIRCLE 149 ON READER-SERVICE CARD

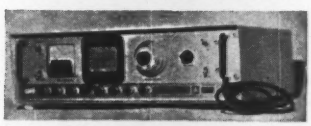
VOLTAGE REGULATOR



New S tabiline automatic voltage regulators, Type IE5101MR, for nominal 120 v operation 60 cps, up to 1 kva, ±5%. Also available for 400 cps. Regulation within 0.6v for line variations between 105 and 135, load current from 0 to 8.3 amp and load PF from 0.7 lagging to 1.0, singly or simultaneously.—*The Superior Electric Co., Bristol, Conn.*

CIRCLE 397 ON READER-SERVICE CARD

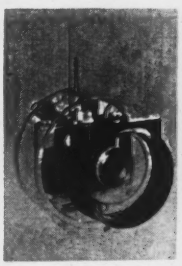
PHASE COMPARATOR



New LPN-400 voltage and phase comparator using built-in CRT and voltmeter measures in-phase and quadrature voltage components, harmonic content and noise in AC signals over the range of 25 cps to 10 kc.—*Autonetics, Division of North American Aviation, Inc., 9150 E. Imperial Highway, Downey, Calif.*

CIRCLE 398 ON READER-SERVICE CARD

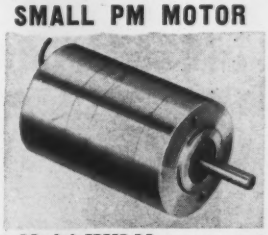
UNDERSEA CAMERA BOX



New compact plastic underwater housing is now available for the ROBOT STAR II Automatic 35mm camera, providing for pictures at depths of down to 100 ft below sea level. Up to 50 exposures without rewinding are possible.—*Karl Heitz, Inc., 480 Lexington Ave., New York 17, N. Y.*

CIRCLE 399 ON READER-SERVICE CARD

SMALL PM MOTOR



New Model HYLM permanent magnet DC motor is the smallest Mil-Spec Barber-Colman sub-fractional horsepower motor. Only 1" dia, the motor features precision ball bearings, constant pressure brush springs and explosion proof housing.—*Barber-Colman, Dept. 2411, Motors and Components Div., Rockford, Ill.*

CIRCLE 400 ON READER-SERVICE CARD

MAGNETIC AMPLIFIER

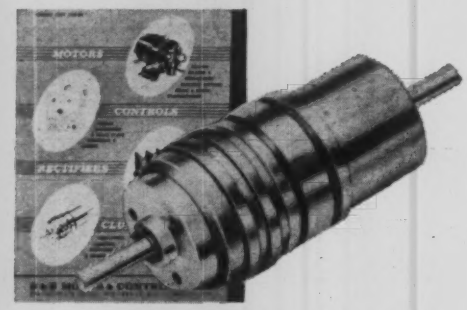
New Preac Amplifier, Type M-5851-C provides a 5 v dc polarity-reversible output with low level inputs such as obtained from thermocouples, strain gages and photocells. Input winding resistance is temperature stabilized for operation from −40° to 85°C. Requires only 2 watts power from 115v 400cps supply.—*Airpax Electronics Incorporated, Seminole Div., Fort Lauderdale, Fla.*

CIRCLE 401 ON READER-SERVICE CARD

MOTORIZED MIXING VALVE

New 21300 Series Mixing Valves control flow from hot and cold inlet ports through cylinder segment which rotates on bearings. Ball bearing suspension allows use of high response servo motor with electrical leads brought out through glass header.—*Aerodyne Controls Corp., 90 Gazza Blvd., Farmingdale, L. I., N. Y.*

CIRCLE 402 ON READER-SERVICE CARD



SIMPLATROL ELECTRIC BRAKES & CLUTCHES

Complete Range - 10 OZ. IN. to 470 LB. FT.

Call us for off-the-shelf delivery — Geared & Non-Geared Electric Motors — Heller Solid State & Thyraton Controllers — Selenium & Silicon Rectifiers — Simplatrol Electric Brakes & Clutches. Send us your specifc inquiries — write for our latest catalog. **B & B MOTOR & CONTROL CORP., 206 Lafayette Street, New York 12, N. Y. WOrth 6-5777**

CIRCLE 150 ON READER-SERVICE CARD

A CONTROL SYSTEM with ORIGINALITY and RELIABILITY

"A major breakthrough in temperature control"

SATURABLE POWER REACTOR CONTROL AND *Range-Lock PROTECTION

MECHANICAL CONVECTION OVENS

GUARANTEED TO OUTPERFORM ALL OTHERS IN RELIABILITY, SAFETY, AND CONTROL ACTION.

POWER-O-MATIC THE NEW STANDARD OF PERFORMANCE

*Range-Lock POWER-O-MATIC-60 COMPLETELY STEPLESS REGULATION OF TEMPERATURE. SWITCHLESS; INFINITELY PROPORTIONAL. FULLY AUTOMATIC.

FAIL-SAFE POSITIVE PROTECTION AGAINST OVERHEATING

POWER-O-MATIC-60 NO AUXILIARY ELEMENTS OR SWITCHES. NO ELECTRONIC AMPLIFIERS OR TUBES. NO PHOTO CELLS. NO TIMING DEVICES. NO MERCURY OR MECHANICAL RELAYS OR SWITCHES TO ARC.

NO MOVING PARTS the first step in RELIABILITY and EFFICIENCY

BETTER PRODUCTS THRU VISION AND SKILL

2 RANGES 356°F. and 650°F.

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ECONOMICAL COMPETITIVELY PRICED with ovens utilizing standard ON-OFF cycling type control systems.

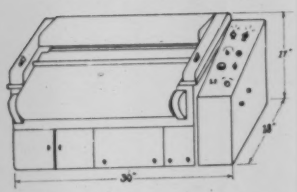
BLUE M Electric Company

138th and Chatham Sts., Blue Island, Illinois

BRANCH: Blue M Engineering Co., 2312 So. Main Street, Los Angeles 7, California

CIRCLE 151 ON READER-SERVICE CARD

DEPTH RECORDER



New Model 418 Survey Depth Recorder using the standard 19" Alden recording head gives resolution at 400 fathoms of better than ±1 fathom. —*Alden Electronic & Impulse Recording Equip. Co., Westboro, Mass.*

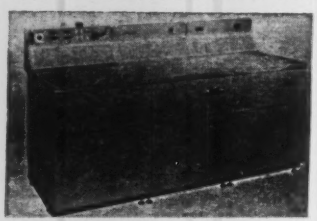
CIRCLE 403 ON READER-SERVICE CARD

RF WATTMETERS AND LOAD

New Model 6254 Termaline RF Wattmeter and Load designed to measure power output and to terminate low power 50-ohm systems, provides direct power readings over the range of 30 to 500 mc with less than 1.15 VSWR. Any one of six standard ranges from 25 to 100 mw may be specified.—*Bird Electronic Corporation, 30303 Aurora Rd., Cleveland 39 (Solon), Ohio.*

CIRCLE 404 ON READER-SERVICE CARD

SONIC CLEANING SYSTEM



New Model SEC-1420 Sonic Energy Cleaning System uses 1500 watts to transducers, matching rinse and dryer cabinets.—*Pioneer Central Div., The Bendix Corporation, Davenport, Iowa.*

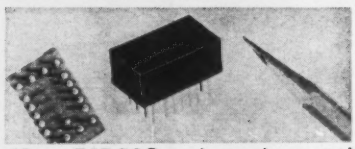
CIRCLE 405 ON READER-SERVICE CARD

RATIO TRANSFORMER

New Model RT-60, general purpose ratio transformer is a precision inductive ac voltage divider featuring high input impedance; operating range is 50 cps to 10kc.—*Gertsch Products, Inc., 3211 So. La Cienega Blvd., Los Angeles 16, Calif.*

CIRCLE 406 ON READER-SERVICE CARD

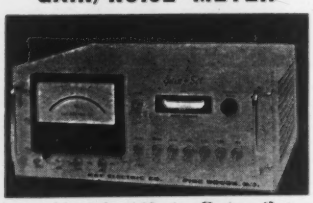
DATA CONVERTER MODULES



New BIPCO® micro-electronic modules convert binary coded decimal information to decimal form. Operate with Burroughs TRIXIE® modules to drive NIXIE® indicator tubes directly from low-level binary coded inputs.—*Burroughs Corporation, Electronic Components Div., P. O. Box 1226, Plainfield, N. J.*

CIRCLE 407 ON READER-SERVICE CARD

GAIN/NOISE METER



New Model 625-A Gain Set, designed to measure gain, loss, noise figure and other microwave characteristics incorporates crystal mixer 20-step attenuator, IF amplifier and detector, AGC amplifier and output meter.—*Kay Electric Co., Maple Ave., Pine Brook, N. J.*

CIRCLE 408 ON READER-SERVICE CARD

READERS & ADVERTISERS

have a lot to look forward to in future issues of

INSTRUMENTS and CONTROL SYSTEMS

Each issue will highlight one of the instrument-control topics below—

- **Temperature Measurement and Control**
- **Telemetering**
- **Recording**
- **System and Data Instrumentation**
- **Process Instrumentation**
- **Analytical Instrumentation and Stream Control**
- **Current and Voltage Control**
- **Electrical Measurement**
- **Pressure Instrumentation**
- **Programming & Timing**
- **Flow Measurement and Control**
- **Strain, Force, Tension and Weight**

ADVERTISERS will share in the resultant reader enthusiasm.

FOR AD SPACE DETAILS—call your nearest ICS rep—see addresses on page 1764.

TELEPHONE PICKUP

New Hum-Bucking Telephone Pick-up Coil designed for use with high impedance input recorders and dictating machines when transcribing telephone conversations cancels stray hum pickup.—*Microtran Company, Inc., 145 East Mineola Ave., Valley Stream, N. Y.*

CIRCLE 409 ON READER-SERVICE CARD

PLUG-IN POLY-DIODE

New Poly-Diode consisting of up to five separate diode junctions, each with an individual lead, formed on a single silicon slice in a computer gate configuration.—*Delta Semiconductors, 835 Production Place, Newport Beach, Calif.*

CIRCLE 410 ON READER-SERVICE CARD

FM SIGNAL GENERATOR

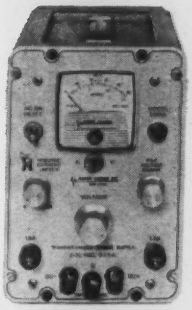
New Model 1001 Signal Generator is continuously tunable through the 100-550 mc range with drift of less than .015% per hr. FM deviation is controllable in two ranges, 0-35 kc and 0-350 kc, and output voltage is 0.25 μv to 100,000 μv into 50 ohms.—*R S Electronics Corporation, P. O. Box 11365, Station A, Palo Alto, Calif.*

CIRCLE 411 ON READER-SERVICE CARD

TRIMMING POT

Models in the new film series have the same physical dimensions as present Atohm wirewound potentiometers, Model 110, 120, 210, 220, and 320.—*Atohm Electronics, 7648 San Fernando Road, Sun Valley, Calif.*

CIRCLE 412 ON READER-SERVICE CARD



NOW WITH SPDJ*

MODEL 5015A

SEMICONDUCTORIZED
POWER SUPPLY
0-50 V.D.C. • 0-1.5 AMP

**Silicon. Small-Signal Transistor Amplifier with Planar Diffused Junction Input Stage*

High stability solid state DC power supply with adjustable current limiting, .05% regulation, 500 μv ripple, .01 Ω source impedance, 50 μs response time, .01 volts drift/24 hours, 55-440~ input.

$234.50 F.O.B. FACTORY

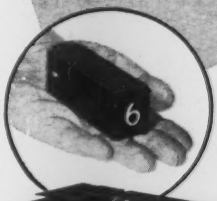
IMMEDIATE DELIVERY

Write For Complete Catalog

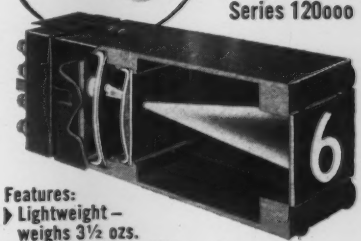
Power Designs inc.
1700 SHAMES DRIVE
WESTBURY, L. I., N. Y.
EDgewood 3-6200 Area Code 516

CIRCLE 153 ON READER-SERVICE CARD

MINIATURIZED! LIGHTWEIGHT!



IN-LINE DIGITAL READOUT
Series 120000



Features:
- Lightweight – weighs 3½ ozs.
- Quick disconnect at rear for easy lamp replacement.

PRICE COMPLETE $35.00

Quantity Prices On Request

WRITE TODAY FOR COMPLETE SPECIFICATIONS

Representatives in principal cities

Over 1000 firms throughout the world in just a few years prove unprecedented acceptance of IEE digital readouts.

INDUSTRIAL ELECTRONIC ENGINEERS, Inc.
5528 VINELAND AVENUE
NORTH HOLLYWOOD, CALIF.

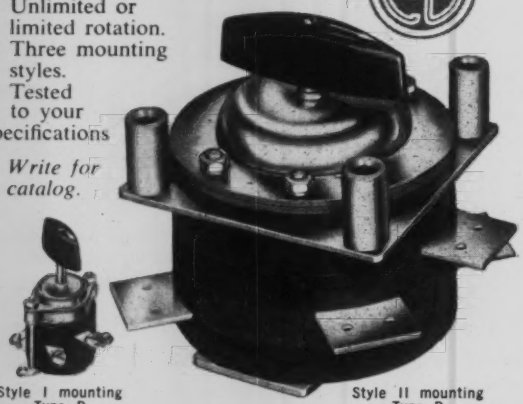
IEE

CIRCLE 154 ON READER-SERVICE CARD

10, 30, 60, 100 and 200 amp.
ROTARY SNAP SWITCH type P

- Positive snap action.
- Up to eight poles.
- Shorting or non-shorting.
- Unlimited or limited rotation.
- Three mounting styles.
- Tested to your specifications

Write for catalog.



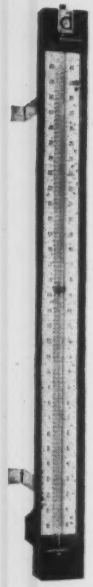
Style I mounting Type P 10 ampere switch

Style II mounting Type P 200 ampere switch

ESCO of WEYMOUTH
ELECTRO SWITCH CORP.
Weymouth (Boston 88), Massachusetts

CIRCLE 155 ON READER-SERVICE CARD

Buy ONE Manometer
Use it for ALL FLUIDS!



- **Dynametrics U-Tube and Single Tube precision-built Manometers feature universal compatability with every manometer fluid. No need to change wetted parts when fluids are changed.**
- **Wetted parts of Pyrex, stainless steel, and non-deteriorating seals will not corrode in presence of water, mercury, TBE, hydrocarbons.**
- **8 U-Tube models, scale heights ±3" to ±25"**
- **13 Single Tube models, scale heights 6" to 100"**

Large multitube and photopanel units also available for maximum utility in minimum space.

Write for Dynametrics "Pressure Measuring Instruments" Catalog

DYNAMETRICS CORPORATION
Northwest Industrial Park, Dept. 15, Burlington, Mass.

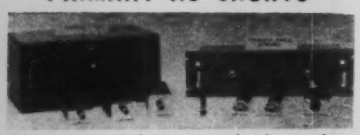
CIRCLE 152 ON READER-SERVICE CARD

MODULAR INSTRUMENTS

New Modular designs in 22 different instruments used as bench or rack models can be quickly incorporated into space-saving systems for microwave frequency and precise time measurements.—*Hewlett-Packard Company, 1501 Page Mill Rd., Palo Alto, Calif.*

CIRCLE 413 ON READER-SERVICE CARD

PRIMARY AC SHUNTS

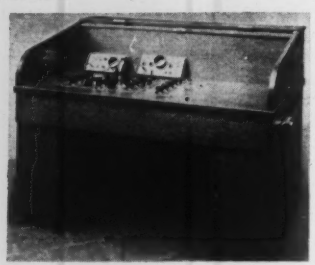


New coaxial, 4-terminal resistor current shunt set designed for a minimum of self-inductance has an accuracy of ac-dc difference for frequencies above 5 cps and below 50 kc to .02%. UHF type connectors provide easy connection.—*Holt Instrument Laboratories, P.O. Box 230, Oconto, Wis.*

CIRCLE 414 ON READER-SERVICE CARD

SCHERING BRIDGE

New Hartmann & Braun SCHERING BRIDGE Model MES 8 for accurate measurement of the dielectric loss factor tan delta and the capacitance of ungrounded or grounded test objects at high and low voltage, and for the determination of the lielectric constant of solid and liquid insulating materials.

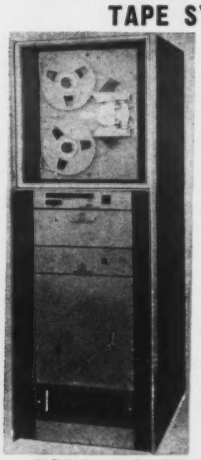


Measuring range for capacitance is from 3 pf to 35 μf and for tan delta from 2 x 10^{-5} to 5.0. Shown in Booth 3305-07.—*Sole U. S. Distributor, E P I C, Inc., 150 Nassau St., New York 38, N. Y.*

CIRCLE 415 ON READER-SERVICE CARD

For More INFORMATION on Products Listed Circle Number on Readers Service Card

TAPE SYSTEM



New PHD-1200 High Density Magnetic Digital Tape System reads and writes tapes at packing densities of 1,200 bits/inch with transient error rates less than 1 bit in 10^8 and permanent error rates less than 1 bit in 10^{10}.—*Potter Instrument Company, Inc., Sunnyside Blvd., Plainview, N. Y.*

CIRCLE 416 ON READER-SERVICE CARD

DIGITAL COUNTERS

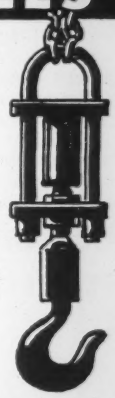
New line of high speed, low torque, direct drive counters give plus and minus, right and left, or directional digital readings.—*Veeder-Root Inc., 70 Sargeant St., Hartford 2, Conn.*

CIRCLE 417 ON READER-SERVICE CARD

WEIGH ELECTRONICALLY

Ametron®
CRANE SCALES

Designed for fast —easy Installation Visual or Printed Weights



Recorder may be mounted in crane cab or in other convenient locations. Prints tape or cards. Available at low costs in 5, 10 and 15 capacities. Rugged construction decreases maintenance.

Write for Brochure B-18

WRITE TO:

STREETER-AMET COMPANY
GRAYSLAKE, ILLINOIS
U.S.A.

CIRCLE 156 ON READER-SERVICE CARD

NOW... A SIX SPEED INSTRUMENT GEAR MOTOR

ALLOWS DIAL SPEED SELECTION WHILE RUNNING.

Here is a new, versatile instrument gear motor with six output speeds, any of which can be quickly and easily changed by operator while motor is running. It is furnished with positive, exactly repeatable ratios of 1:1, 2:1, 5:1, 10:1, 20:1 and 50:1. A variety of basic synchronous motor speeds is available. The unit is built to standard NEMA Size 25 Frame.

This dependable, compact gear motor can be used as a new instrument component for prototype testing or in breadboards where its adjustable speed feature will give better, faster results.

CHART DRIVES • SPEED REDUCTORS • INSTRUMENT DRIVE SYSTEMS

INSCO COMPANY
DIVISION OF BARRY WRIGHT CORP.
GROTON, MASSACHUSETTS

CIRCLE 157 ON READER-SERVICE CARD

TANTALUM CAPACITOR

New HV Type axial lead-type tantalum foil capacitors have single-unit ratings to 300 wvdc, over the temperature range −55° to +85°C, and to 250 wvdc from −55° to +125°C. —*Tansitor Electronics, Inc., West Road, Bennington, Vt.*

CIRCLE 418 ON READER-SERVICE CARD

ACCELEROMETERS SINGLE AXIS

New single axis accelerometers which employ fluid damping and torsion-bar spring restraint are designed for low-cost inertial systems where the output is integrated to provide velocity and distance information. Complete performance characteristics on request.—*Kearfott Div., General Precision, Inc.*, 1150 *McBride Ave., Little Falls, N. J.*

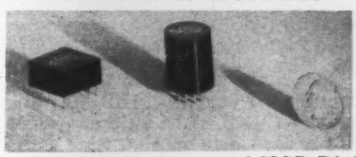
CIRCLE 419 ON READER-SERVICE CARD

DIGITAL CLOCKS

New Model 2000 Series Digital Clocks with 8-4-2-1 binary-coded-decimal outputs parallel with decimal outputs are combined in the same clock with a separately wired common for each decimal digit position to permit easy conversion to serial form, and also actuate visual displays, tape printers, and typewriters without code conversion.—*Chrono-Log Corporation, Box* 4587, *Philadelphia* 31, *Pa.*

CIRCLE 420 ON READER-SERVICE CARD

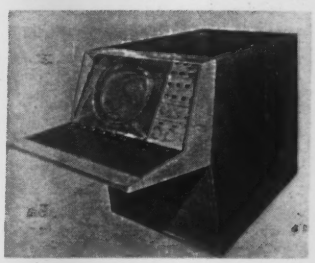
DIGITAL NOR MODULES



New U-Series Universal NOR Digital Circuit Modules operate over the frequency range of 0 to 25 kcs, meeting the requirements of MIL-STD-202B. First Four units are: 1) Dual 3-input NOR; 2) power driver; 3) converter unit to convert dual NOR unit into flip-flop, one-shot or free-running multivibrator; and 4) a pulse gate unit.—*Engineered Electronics Co.*, 1441 *E. Chestnut Ave., Santa Ana, Calif.*

CIRCLE 421 ON READER-SERVICE CARD

DIRECT VIEW DISPLAY



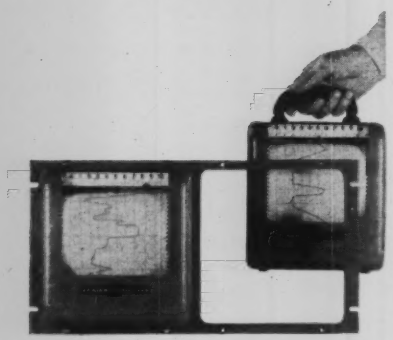
Advanced direct-view display S-C 1090 console, for monitoring digital computers, will be used in command decision making utilizing man-machine information systems where it is necessary to continuously monitor a large store of changing information. Similarly, the console can be used for other systems such as air traffic control, information retrieval and automatic process control. The Charactron shaped beam tube permits rapid changes of displays, even beyond the limit of human perception.—*General Dynamics/Electronics, Information Technology Div.*, 1895 *Hancock St., San Diego* 12, *Calif.*

CIRCLE 422 ON READER-SERVICE CARD

VARIAN
Potentiometer
RECORDERS

The logical "first choice"

because . . .



TOTAL DESIGN IS

FUNCTIONAL

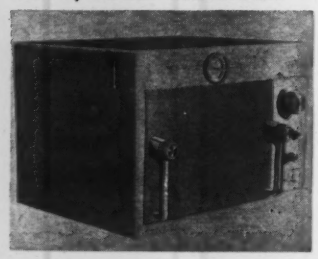
Carry it anywhere — put two side-by-side in a rack. Its shape is ideal for both. And its performance is multi-purpose too: wide choice of ranges, accessories, options and plug-ins. Chances are it has the capability to record for you in a variety of assignments.

The Varian G-11A is 10" high, 8¾" wide, 7¾" deep; 15 lbs.; 1% accuracy; ranges from 10 mv to 100 v d. c. full scale; wide choice of charts and chart speeds for millivolt, milliamp and direct temperature recording from thermocouples. Write for full specifications to Instrument Division.

VARIAN associates
PALO ALTO 27, CALIFORNIA

CIRCLE 158 ON READER-SERVICE CARD

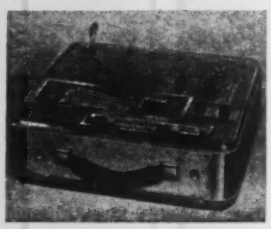
HOT/COLD CHAMBER



New Miniature High-Low Temperature Chamber, Model C-106, cooled by liquid CO_2, provides faster heating and cooling rates, closer temperature control and distribution, and increased operating economy. Test volume is 640 cu-in. Temperature range is from −100° to 500°F with a control accuracy of ±0.5°F.—*Wyle Laboratories, Inc., El Segundo, Calif.*

CIRCLE 423 ON READER-SERVICE CARD

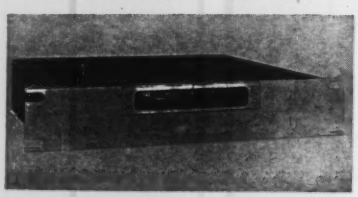
DIRECT WRITING RECORDER



New Tracemaster single-channel direct writing recorders are self-contained in attache-size case with separable top cover and weigh just 20 lbs. Three-channel models can be operated in vertical, horizontal or tilted positions and feature interchangeable plug-in type amplifiers. Both models accommodate 200 ft of chart, push-button controlled, to speeds of 1, 5, 20, 100mm/sec and employ direct-carbon transfer writing method. Frequency response dc to 100 cps at 25mm peak-to-peak amplitude, −3db at 125 cps., ±5%.—*American Optical, Instrument Div., Buffalo* 15, *N. Y.*

CIRCLE 424 ON READER-SERVICE CARD

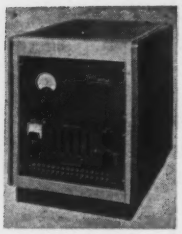
MINI SYNCHRO BRIDGE



Laboratory standard bridges for checking synchros (MSB 5) or resolvers (MRB 5) to 20 ppm accuracy are available in miniaturized models. Both instruments provide measurements in 5° steps from 0-360°. Absolute accuracy from 0-800 cps is .002%. Frequency range extends to 10 kc at reduced accuracy.—*Julie Research Laboratories, Inc., 603 West 130th St., New York* 27, *N. Y.*

CIRCLE 425 ON READER-SERVICE CARD

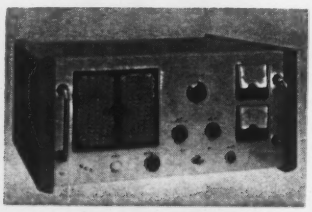
AIRBORNE-PARTICLE SIZE ANALYZER



New Model PC-200A Particle Counter displays the number of particles present in 15 sub-ranges of sizes from 0.32 μ to 8.0 μ diameter. Counts appear visually on decade counters, but can be recorded on digital tape or a strip-chart recorder, or both. At the normal air flowrate of 100 cc/min the count rate without excessive coincidence loss is 7340 particles. If no particles are present, the instrument will not respond.—*Royco Instruments Inc.,* 440 *Olive St., Palo Alto, Calif.*

CIRCLE 426 ON READER-SERVICE CARD

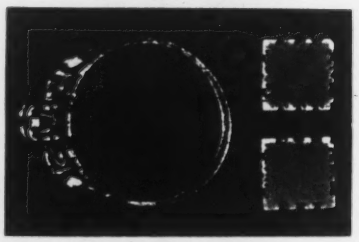
POWER SUPPLY



New Model QCR 36-30 transistorized power supply features a continuously adjustable output of zero to 36 vdc. Precise regulation of ±0.01% + 1 mv and reduced ripple of 0.5 millivolts RMS maximum, results from a new circuit concept.—*William Buck, Sorensen Products, Richards Ave., S. Norwalk, Conn.*

CIRCLE 427 ON READER-SERVICE CARD

WAFER RESISTORS



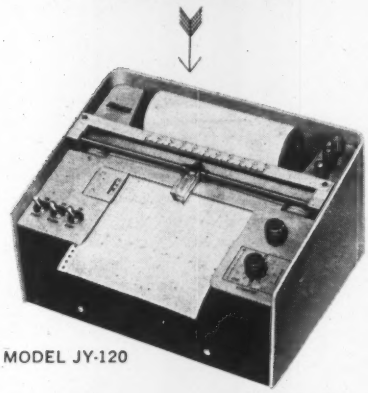
New line of micro-miniature resistors on the standard RCA wafer, for micro-module developments, are made to customer specifications. Dimensions of wafer are .31" x .31" x .010" with 12 interconnecting notches. Electrical specifications are: Resistance range from 100 ohms to 100 K ohms, tolerance ±1%, temperature coefficient of 100 PPM/°C and a maximum dissipation ½ watt per wafer. As many as four resistive elements can be placed on a single wafer. Sample units available.—*Dale Electronics, Inc., Columbus, Neb.*

CIRCLE 428 ON READER-SERVICE CARD

NESCO GRAPHIC RECORDER

MEASURES 1/100TH OF A MILLIVOLT.

Pen speed 1/2 sec. full scale



MODEL JY-120

Here is fast, accurate potentiometric recording at a low price—only $535.00. Both accuracy and sensitivity are ½% of span. Maximum signal source resistance, 50K ohms.

Step selection of ranges—from 1MV to 10V, provided by attenuator on front panel.

Minimum zero drift—due to a null-balance, servo-type, potentiometric, chopper-stabilized system.

2 other ranges available:
10 MV fixed span, Model JY-100 . **$320.00**
10 MV to 100 V, Model JY-110 . . **$392.50**

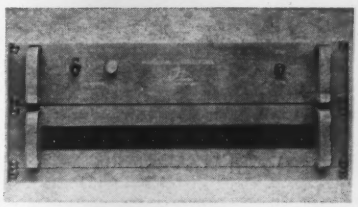
Write for JY Bulletins

NESCO

NESCO INSTRUMENTS, INC.
Manufacturers of Precision Recording Instruments
638 West 17th Street • Costa Mesa, California

CIRCLE 159 ON READER-SERVICE CARD

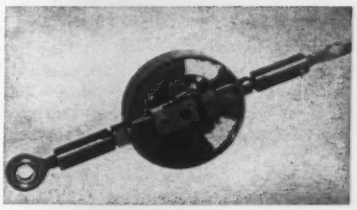
TRANSISTOR TEST COUNTER



New Transistor Fault Counter Model C-10 displays the total number of transistors tested on the indicator labeled "STARTS". Indicators 1-10 display the number of transistors which do not pass tests 1-10, which may be standard transistor measurements, such as ICBO, IEBO, VBE, VCE Sat., HFE, alpha, beta, etc.—*Optimized Devices, Inc., 864 Franklin Ave., Thornwood, N. Y.*

CIRCLE 429 ON READER-SERVICE CARD

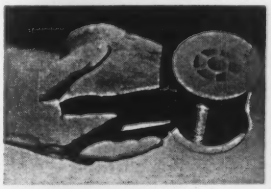
LOAD TRANSDUCERS



New Load Cells designed to measure both tension and compression in seven models with full load ratings from 1000, to 100,000 pounds are standard. Temperature compensation provides high stability in rapid changes in temperature, even where there is a steep temperature gradient across the transducer. The units can be used without damage from —300°F to 750°F.—*Microdot Inc., 200 Pasadena Ave., South Pasadena, Calif.*

CIRCLE 430 ON READER-SERVICE CARD

HIGH PERMEABILITY MAGNETWIRE

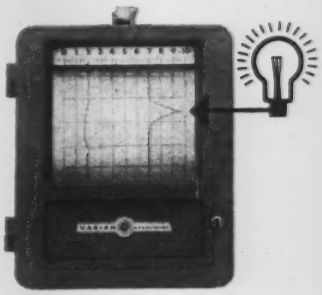


New Netic, Co-Netic AA and Co-Netic B alloy wires with high permeability offer a lower reluctance path to the magnetic flux concentrating the field in transformer and other inductance applications. For a given coil or transformer, the number of turns and wire diameter can be reduced and still result in an equivalent resistance and inductance.—*Magnetic Shield Div., Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill.*

CIRCLE 431 ON READER-SERVICE CARD

VARIAN Potentiometer RECORDERS

Offer exceptional versatility because...



THERE ARE ACCESSORIES FOR ALARM/CONTROL

Alarm and control switches, and retransmitting slide wires, add a valuable dimension of simple control to the already-versatile two-channel G-22. With these optional accessories they can work unattended to control two variables within the 1% accuracy of the recorder, while making a permanent record of what has happened.

1% accuracy, spans from 10 mv to 500 v, 1 second full-scale balance time, two chart speeds standard, four optional (3/8"/hr. to 16"/min.), full scale zero adjust, event markers and other options. Portable and rack-mounted models available from $1,075. Write Instrument Division:

VARIAN associates
PALO ALTO 27, CALIFORNIA

CIRCLE 158 ON READER-SERVICE CARD

ULTRAgraph

444

CUT DATA COSTS

A Rugged, Lightweight, Direct Writing Oscillograph, employing a LOW COST Tungsten light source.

- 4 to 6 channels.
- Weight — 15 pounds.
- 4 selectable speeds.
- Optional grid lines.
- 2,000 cps frequency response.
- Sensitivities from .4 mv/inch.
- 110 volts — 60 cycles.

Our APPLICATIONS ENGINEERS invite your inquiry

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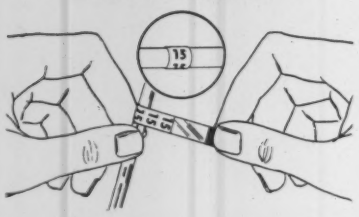
Vibro-Meter Corporation, Fribourg, Switzerland in Free Europe

CIRCLE 160 ON READER-SERVICE CARD

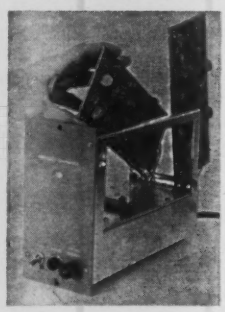
WIRE MARKERS



New E-Z-Code Self-Laminating Wire Markers protect markings from all conventional greases, chemicals, etc. When coded marker is applied to wire the remaining protective clear portion wraps around itself, causing it to laminate permanently over the coded area thus protecting itself. Brochure, *samples* on request.—*Westline Products Div. Western Lithograph Co., 688 East 2nd St., Los Angeles 54, Calif.*

CIRCLE 432 ON READER-SERVICE CARD

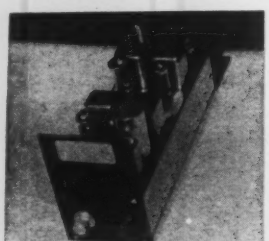
FREQUENCY COMPARATOR



New all-solid-state Frequency Comparator, Type 35-2001, accepts any input frequency from 1 cps to 50 kc, compares it with precision reference oscillator. Difference in frequency results in output signal proportional to error to actuate control device.—*Daystrom-Wiancko Eng. Co., 255 North Halstead Ave., Pasadena, Calif.*

CIRCLE 433 ON READER-SERVICE CARD

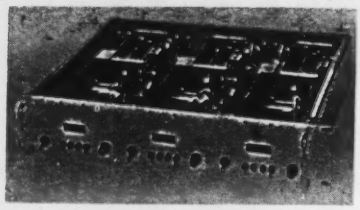
DC AMPLIFIER



New Coldstream model 1T300 dc amplifier utilizes a second harmonic modulator operating at an excitation frequency of 2000 cps amplified by a two-stage ac amplifier whose output feeds a phase-sensitive demodulator. This bi-directional output is fed in turn to a balanced push-pull cathode follower. A portion of the output is fed back to the modulator for gain and temperature stabilization. Gain steps of 10, 100, 1000 and 3500 are standards.—*Coldstream Engineering Co., Box 1893, Tulsa, Okla.*

CIRCLE 434 ON READER-SERVICE CARD

REMOTE ANGLE INDICATOR

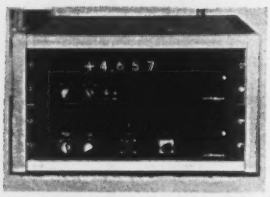


New three-channel, transistorized remote angle indicator for remote readout of inertial platform orientation is completely housed in a 3½" x 19" x 14" panel.

Each channel's CX-type remote angle sensor feeds into a CT resolver connected to a counter through a 360:1 anti-backlash gear train. Each position indicator displays the position of the inertial platform in degrees and minutes.—*American Electronics, Inc., Instrument Div., 9503 West Jefferson Blvd., Culver City, Calif.*

CIRCLE 435 ON READER-SERVICE CARD

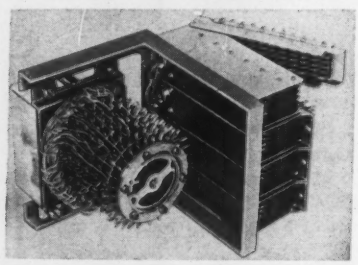
DIGITAL MULTIMETER



New digital multimeter combines a Voldicon V16-AD basic voltage to digital converter with a multi-purpose signal conditioner and programming accessory modules to measure absolute ac or dc values or voltage ratios between dc and dc, ac and ac or ac and dc in any combination. Operating modes and ranges may be selected by manual switch or by remote signal programming. Unlimited applications in automatic checkout systems.—*Adage Incorporated, 292 Main St., Cambridge 42, Mass.*

CIRCLE 436 ON READER-SERVICE CARD

ROTARY STEPPING SWITCH



New Stepping Switch providing 240 individual connections for access to control, selection, sequencing or pulsing circuits is available completely wired to plug-in connectors.—*North Electric Co., Electronics Div., Galion, Ohio.*

CIRCLE 437 ON READER-SERVICE CARD

KENDALL/GOVERNAIRE

SEND FOR CATALOG ON

PRECISION AIR REGULATORS

Large balanced supply and relief valves provide rapid response with precise control plus maximum flow for minimum size.

Kendall is a direct acting, spring actuated, bleed type valve. Governaire is pilot assisted. Both lines have a unique boost action with increased flow rate that offsets downstream pressure losses. Both are immune to supply pressure variations and suited to either high-flow or dead-end applications. With the Kendall/Governaire lines, Stratos offers the largest selection of standard and special precision pressure regulators, relays and volume boosters in the industry.

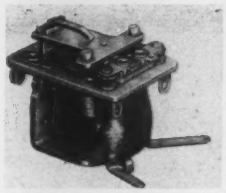
For your copy of the Stratos Engineering Manual and Data Sheets illustrated above, write

STRATOS®

A DIVISION OF
FAIRCHILD ENGINE & AIRPLANE CORPORATION
Bay Shore, L. I., N.Y.

CIRCLE 161 ON READER-SERVICE CARD

MINI DC RELAY



New Advance MK Series Miniature DC Relay has specs including contact arrangement—SPDT and DPDT; contact rating—1 amp res, 0.6 amp ind @ 26.5 vdc or 115 vac; pull-in power (nominal)—SPDT: 0.75 w, DPDT: 1 w, etc.—*Elgin National Watch Co., Electronics Div.*, 2435 *N. Naomi St., Burbank, Calif.*

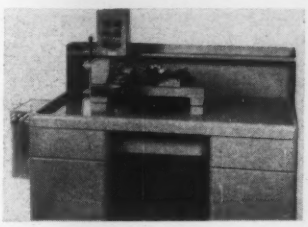
CIRCLE 438 ON READER-SERVICE CARD

LATCH-IN FAULT INDICATOR

New ¾" sealed miniature magnetic latch-in Fault Indicator in wide current and voltage ranges provides flexibility in meeting circuit requirements. Disc-type flag, colored or imprinted to designate function monitored, rotates behind sector window. Device maintains positive indication even when unenergized under vibration from 10 to 500 cycles at 10 G.—*Minneapolis-Honeywell, Precision Meter Div., Grenier Field, Manchester, N. H.*

CIRCLE 439 ON READER-SERVICE CARD

PRECISION LATHE



New Reliance Electronic Motor Drive used on Model 750 Lathe furnishes speeds from 300 to 3500 rpm using 1:1 pulley ratio, or from 600 to 7000 rpm using 2:1 pulley jump.—*F. W. Derbyshire, Inc.*, 265 *Bear Hill Rd., Waltham* 54, *Mass.*

CIRCLE 440 ON READER-SERVICE CARD

For PRODUCTS LISTED
Circle Number on
Readers-Service Card

DAVIS

TRACE HYDROCARBON DETECTOR

Model 6500

- The Davis Trace Hydrocarbon Detector accurately and continuously detects and measures such organic compounds as hydrocarbons, aldehydes, ketones, alcohols, and amines. Based on a newly-developed *flame ionization technique*, this new detection unit features cubicle construction with indication and adjustable alarm functions. Recording is optional.

- A reliable, non-poisoning detecting method for most troublesome organic gases or solvents, the Davis Trace Hydrocarbon Detector incorporates a unique desensitizing arrangement that permits handling of higher concentrations (% by volume).

A portable version, Model 650 is also offered. This compact unit is ideal for laboratory or field analysis.

INSTRUMENT DAVIS DIVISION

DAVIS INSTRUMENTS

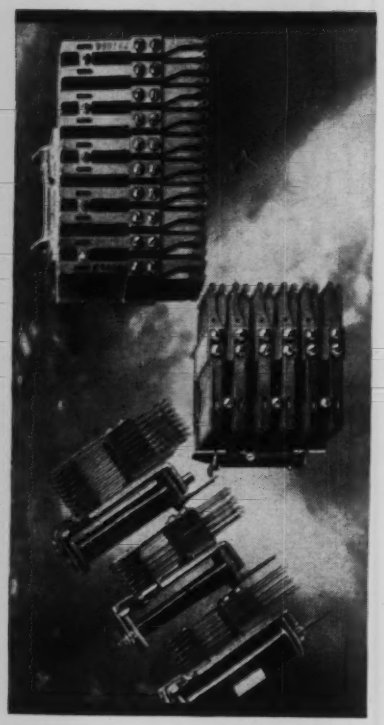
DIVISION OF
DAVIS EMERGENCY EQUIPMENT CO., INC.

80 Halleck Street
Newark 4, New Jersey

CIRCLE 162 ON READER-SERVICE CARD

Stromberg-Carlson®

RELAYS



Telephone-type quality • reliability durability

TYPE A: general-purpose. Up to 20 Form "A" spring combinations.

TYPE B: gang-type. Up to 60 Form "A" spring combinations.

TYPE BB: up to 100 Form "A" springs.

TYPE C: two on one frame. Ideal where space is tight.

TYPE E: characteristics of Type A, plus universal mounting. Interchangeable with other makes.

Types A, B, and E are available in high-voltage models. Our assembly know-how is available to guide you in your specific application. If you desire, we can also provide wired mounting assemblies.

Details on request from these Stromberg-Carlson offices: Atlanta—750 Ponce de Leon Place N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Avenue; San Francisco—1805 Rollins Road.

GENERAL DYNAMICS
TELECOMMUNICATION

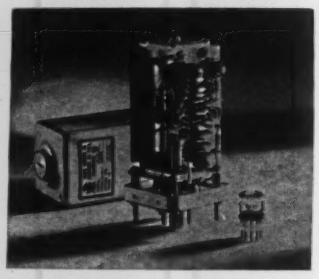
CIRCLE 163 ON READER-SERVICE CARD

AUTOMATIC VTVM

New DYNAMATIC 375-VTVM automatic vacuum-tube voltmeter provides an individual wide-view direct reading scale for each of four ranges. Only one scale is visible at any one time. Once you set the range switch properly, it is impossible to read the wrong scale. Complete specification in catalog sheet AP18 on request.—*B & K Manufacturing Co., 1801 W. Belle Plaine Ave., Chicago 13, Ill.*

CIRCLE 441 ON READER-SERVICE CARD

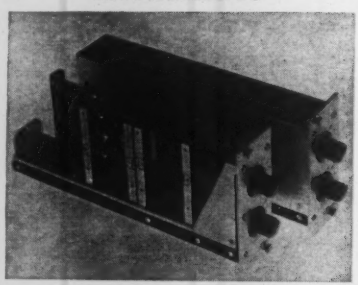
FREQUENCY STANDARD



New JKTO-42 low-drive-level, current limiting osciillator designed for laboratory or plant environment for frequencies up to 5 mc, also new crystals, crystal ovens will be displayed at Wescon.—*James Knights Co., Sandwich, Ill.*

CIRCLE 442 ON READER-SERVICE CARD

TRANSISTORIZED INSTRUMENTS

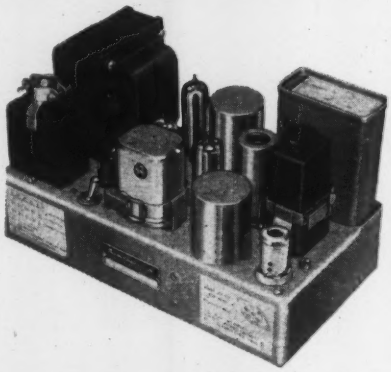


New 1800 Series instruments use solid-state sub-modules including operational amplifiers to provide a variety of gain ranges, gain steps, frequency responses and outputs.—*Burr-Brown Research Corp., Box 6444, Tucson, Ariz.*

CIRCLE 443 ON READER-SERVICE CARD

For More Information
Circle Appropriate
Number on Readers
Service Card

Stability... Sensitivity... ONE MICROVOLT



The *Thermo Electronic*® High-Gain Relay Amplifier

gives you extreme sensitivity—stability—accuracy—detects even the slightest difference between reference and measuring points in process controls, monitor systems, and for go-no go quality control.

In operation the Thermo Electronic Relay Amplifier recognizes the polarity of *one microvolt* dc signal—converts to ac—and amplifies to actuate a master relay in accordance with the input signal polarity. It will tolerate line voltage fluctuation from 90 to 130 volts and external input resistance to 10,000 ohms.

To protect your valuable equipment or process output, the new T.E. Relay Amplifier incorporates a built-in fail-safe circuit to shut down operation in case of power failure, component or transducer breakdown. All parts are standard, easily replaced, without effect on operating characteristics. Negative feedback reduces internal noise to negligible level.

Just 6½ lbs. weight—4½" x 3¾" x 6", compact—to fit in almost anywhere.

Write today for Bulletin 90-12

Thermo Electric CO., INC.
SADDLE BROOK, NEW JERSEY

In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

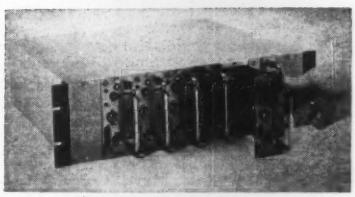
CIRCLE 164 ON READER-SERVICE CARD

T-D POWER SOURCE

New Model TD6M Tunnel Diode Power Source provides highly stable voltage and current biases in the 0-6Vdc and millivolt region. Current rating is 0-100 ma. Regulation corresponds to 0.05% vac, 60-400 cps and 0-100% load change.—*Electronic Research Associates, Inc., 67 Factory Pl., Cedar Grove, N. J.*

CIRCLE 444 ON READER-SERVICE CARD

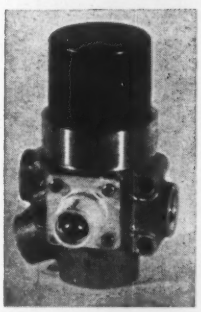
TRANSDUCER SIGNAL CONDITIONER



New PS-290 Power Supply and the PB-290 Power and Balance unit incorporate plug-in card circuits for up to eight transducer channels. Bridge completion, balancing, and calibration resistors are easily accessible from the front. Output ripple is less than 500 μv peak-to-peak or 200 μv RMS; and line regulation is less than 0.02%. Isolation is less than 0.01 μamp at 60 cps, and output impedance is less than 0.05 ohm.—*Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif.*

CIRCLE 445 ON READER-SERVICE CARD

SOLENOID VALVE



New Three-way Two-position direct actuated poppet type Aircraft Quality Solenoid Valve for use in rocket systems has been qualified for use with air, helium, hydraulic oil, hydrogen peroxide, fuel, anhydrous ammonia, UMDH, IRFNA, etc., depending on elastometers used in O-rings. —Solenoid operates at 17-30 v dc.— *Captive Seal Corporation, 121 Clinton Rd., Caldwell, N. J.*

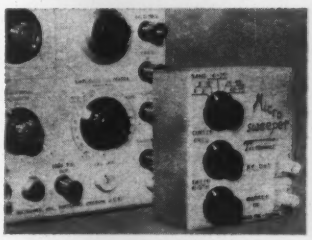
CIRCLE 446 ON READER-SERVICE CARD

BALANCING COMPUTER

New computer accepts data as to frequency, amplitude and phase of vibration unbalance and by a simple manipulation of dials determines needed location and amount of weight to be added or removed. Eliminates calculations, vector solutions and 80% of balancing time.—*International Research & Development Corp., Worthington, Ohio.*

CIRCLE 447 ON READER-SERVICE CARD

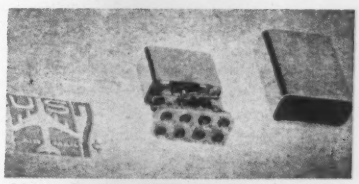
SWEEP GENERATOR



New plug-in sweep generator for alignment of IF stages and wide-band amplifiers attaches to most laboratory oscilloscopes without power cables or batteries. Features no mechanical moving parts, independent center frequency and sweep width controls, variable sweep rates and 10^4 short term stability.—*Teltronics, Inc., 277 Main St., Nashua, N. H.*

CIRCLE 448 ON READER-SERVICE CARD

MICRO RELAY

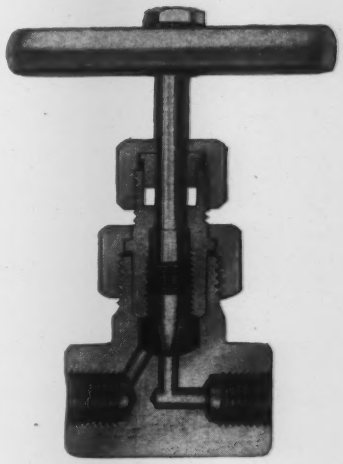


New Series MM-22 Sealed Microminiature DPDT Relay fabricated under "Clean Room" conditions is expected to have a life of ten million operations in dry circuit applications. Minimum contact life is 100,000 operations at 3 amps. Max operate and release times are 5 msec each. The relay functions over a temperature range of −65° to 125°C and under severe vibration and shock.—*Automatic Electric Co., Northlake, Ill.*

CIRCLE 449 ON READER-SERVICE CARD

For More Information
Circle the Number on the
Reader-Service Card.

AMERICAN® NEEDLE VALVES



Handle the toughest meter manifold jobs and corrosive field services. Eliminate gland leaks.

Teflon-packed forged steel American Needle Valves stand up under all conditions. Stainless or carbon steel precision-machined valve bodies are ideally suited for welding. Stainless steel centerless-ground valve stem simplifies valve repacking under pressure.

Standard valves design-rated for pressures to 5,000 psi at 70°F. Hydrostatically tested to 10,000 psi (twice rated working pressure) and individually inspected on request. Furnished with graphite-impregnated asbestos packing for temperatures above 450°F. Angle or straight patterns — screwed or union bonnets.

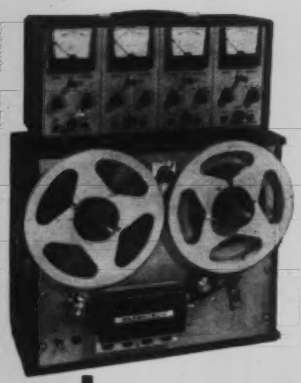
Write for Bulletin 420.

AMERICAN METER COMPANY

Sales Offices in Principal Cities

CIRCLE 165 ON READER-SERVICE CARD

data recorders expensive?



not any more

now, Mnemotron gives you a complete, easy-to-use 4-channel analog tape record/reproduce system with **0.2% precision** for only **$3,495**

Complete with 10½" reel tape transport, rack mounted

Mnemotron offers a unique pulsed FM principle and fully transistorized, self-contained unit that records all analog • data • data acquisition • storage, analysis and reduction • time scale contraction and expansion • programming • computer read IN and read OUT • dynamic simulation. With Mnemotron, you can do more with paper recorders . . . expanding frequency response and channel capacity, saving you from being deluged with data, permitting you to look at the same data at different time scales.

Model M204 features:
Any 2 adjacent speeds: 3¾, 7½, 15 ips. Added low speed available on special order.

Frequency Response:
- DC—800 cps @ 15 ips
- DC—400 cps @ 7½ ips
- DC—200 cps @ 3¾ ips

Linearity: 0.2% full scale.
Noise: Less than —50 db full scale.
Crosstalk: Below 70 db.
Extended range systems also available.

complete details.
Write, wire, phone today for

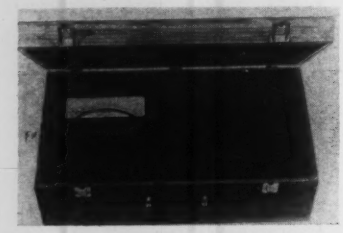
MNEMOTRON CORPORATION

37 S. Main St., Pearl River, N. Y.
- **PEarl River 5-4015 (914)**
- **Cables: Mnemotron**

precision analog data tape recorders and biological computers

CIRCLE 166 ON READER-SERVICE CARD

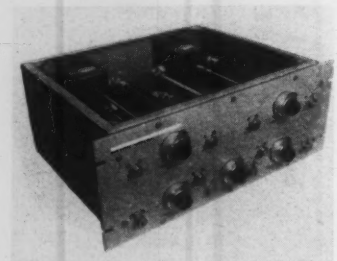
AC VOLTAGE STANDARD



New Model FLH potrable thermocouple transfer standard measures influence of frequency (ac/dc differences) to an accuracy of ± .01% from 1.5 v to 1125 v over a frequency span of 20 to 50,000 cps to assure ac voltage measurements accurate within ± .013%.—*Sensitive Research Instrument Corp., 310 Main St., New Rochelle, N. Y.*

CIRCLE 450 ON READER-SERVICE CARD

FREQUENCY METER



Accurate measurement of frequencies in S, C and X bands is accomplished by new panel mounted unit which incorporates series of tunable bandpass filters. Low-pass filter eliminates spurious and tuning is by single duo-dial counter.—*Frequency Standards, P. O. Box 504, Asbury Park, N. J.*

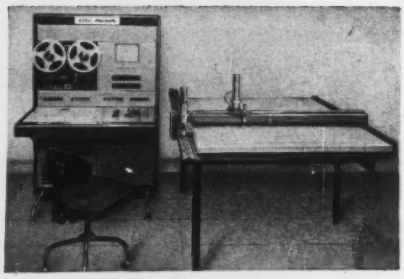
CIRCLE 451 ON READER-SERVICE CARD

INDUCTANCE CONTROLLED OSCILLATOR

New Model LSE inductance controlled oscillator requires only two wires from any variable inductor transducer. Tunes to any IRIG channel, V_{out} is 3 v rms, Z_{out} is 100 ohms and harmonic distortion is only 3%. Transistorized to operate on 24 to 32 v dc over the —65° to 165°F range.—*PACE Engineering Co., 13035 Saticoy St., No. Hollywood, Calif.*

CIRCLE 452 ON READER-SERVICE CARD

For More Information
Circle Corresponding Number
On Reader Service Card



New, fully automated Aero/Digitork X-Y PLOTTER with digital input/output

Check These Key Features:
- 100% digital actuation
- .0015" operating accuracy
- All solid-state electronics
- Input-output format includes punched tape or cards, or magnetic tape
- Option: point-to-point or continuous line modes and automatic incremental scale factors
- Models: from 9" x 17" to 5' x 10' plotting area

New Brochure: Write for brochure describing applications, specs. Or phone Frank McWilliams, Mgr., Coordinatograph Sales, GL 7-3000.

AERO SERVICE CORPORATION
Industrial Electronics Division
210 E. Courtland St., Phila. 20, Pa.

CIRCLE 167 ON READER-SERVICE CARD

Ultra-fast Optics

for

INFRA-RED

Instrumentation

Reflective Optics

Cassegrain Systems

Paraboloids to f/.3

Off-axis mirrors

Refractive Optics

Si and Ge Optics

IR Windows

Aspherics

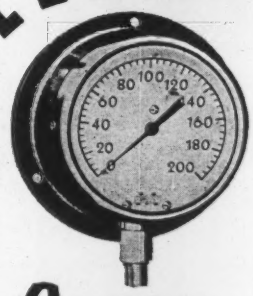
Mechanical Mountings

John Unertl Optical Co.

3551-55 East St.
Pittsburgh 14, Pa.

CIRCLE 168 ON READER-SERVICE CARD

MARSHALLTOWN



Gauges

The right gauge for your specific needs

A complete line of gauges in stock available for early delivery. Gauges from 10-inches water pressure to 30,000 P.S.I. to meet your specifications on any equipment.

- Pressure
- Vacuum
- Compound
- Altitude
- Combination
- Diaphragm
- Hydraulic
- Special Purpose
- Dial Thermometer (Vapor Tension or Bi-Metal)

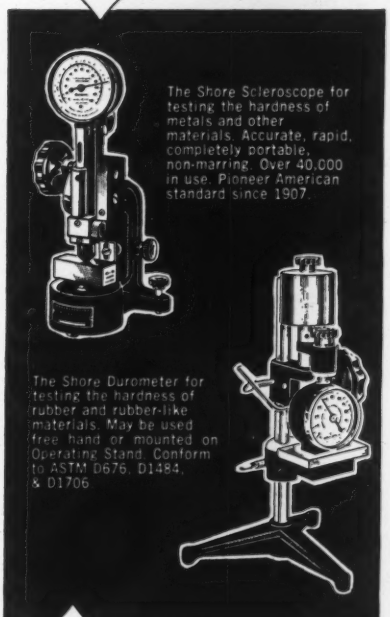
Let Marshalltown answer your gauge problems . . . write for information and prices.

MARSHALLTOWN, IOWA
A Subsidiary of The Electric Autolite Co.
MARSHALLTOWN MFG., INC.

CIRCLE 169 ON READER-SERVICE CARD

Shore

HARDNESS TESTING

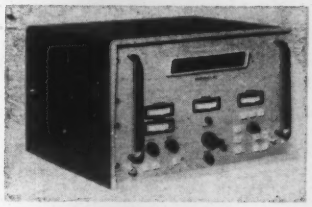

The Shore Scleroscope for testing the hardness of metals and other materials. Accurate, rapid, completely portable, non-marring. Over 40,000 in use. Pioneer American standard since 1907.
The Shore Durometer for testing the hardness of rubber and rubber-like materials. May be used free hand or mounted on Operating Stand. Conform to ASTM D676, D1484, & D1706

Shore

INSTRUMENT & MFG. CO., INC.
90-35 VAN WYCK EXPRESSWAY
JAMAICA 35, N.Y., U.S.A.

CIRCLE 170 ON READER-SERVICE CARD

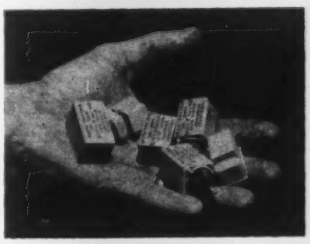
FM SIGNAL GENERATOR



New Microdot 412 FM signal generator, for checkout of command receivers in the 400-550 mc band, features direct 6-place digital readout of frequency accurate to ± 1 kc. It is frequency modulated up to ± 300 kc by external signal, varying in frequency from 300 cps to 100 kc.—*Microdot, Inc., 220 Pasadena Ave., South Pasadena, Calif.*

CIRCLE 453 ON READER-SERVICE CARD

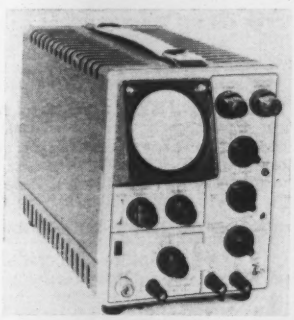
MICRO FREQUENCY GENERATOR



New crystal-controlled microcircuitry frequency generator weighing 1.75 oz generates any selected frequency in the 25 cps to 1 mc range accurate to .01% (.001% on special orders). Solder connections or plug-in mountings to printed circuit boards.—*Varo Inc., 2201 Walnut St., Garland, Tex.*

CIRCLE 454 ON READER-SERVICE CARD

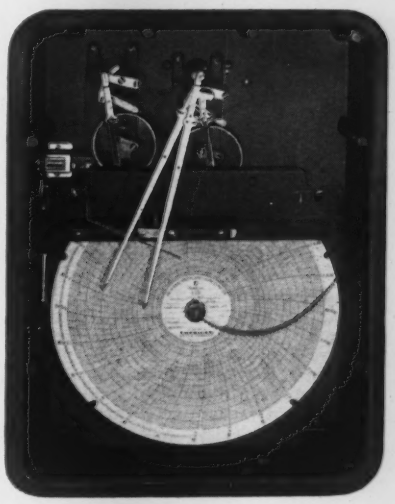
PORTABLE SCOPE



New Model 32 uses new CRT with post-deflection acceleration and 3.5 kv potential to give unusually sharp, bright trace. DC coupled amplifier has 7.5 mc bandwidth, sensitivity of 100 mv/cm and rise time of 50 nsec. Weighs only 16 lbs., for field service on computers, TV and general Lab use.—*The Scopes Company, Inc., P. O. Box 56, Monsey, N. Y.*

CIRCLE 455 ON READER-SERVICE CARD

INTEGRATING ORIFICE METERS



American® Integrating Orifice Meters provide more accurate measurement by the continuous multiplication of the square root of the measured differential by the square root of the absolute line pressure.

Single, double and duplex-integrating models available in a wide range of manometer types and working pressures. Dustproof, die-cast aluminum cases... Gasclok and electric instrument chart drives. Also supplied with American Telecounter for remote readings.

See Bulletin 401 for details.

AMERICAN METER COMPANY

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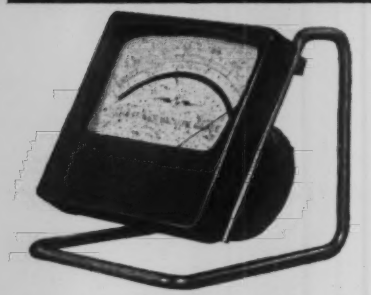
CIRCLE 171 ON READER-SERVICE CARD

HASTINGS "COMPACT VACUUM GAUGES"



NEW DESIGN
IMPROVED PERFORMANCE

Ideal for panel mounting or building into other equipment

The new compact design and miniaturized circuitry of these Hastings "Compact" Vacuum Gauges greatly improve their performance, reduce their cost, and increase their versatility, thereby making them ideally suited for every type of vacuum gauge application.

The 4-inch meter, complete with all gauge tube circuitry attached to the rear, measures only 2⅜" in depth and is ready to be mounted on any panel, built into other equipment or used on a polished brass desk stand as illustrated. It can also be furnished complete within its own cabinet if desired.

Multiple-position switching attachments are available, allowing monitoring of up to 5 positions with a single indicator.

Hastings "Compact" Vacuum Gauges utilize the rugged but sensitive Hastings gauge tubes, available in either metal or pyrex construction, and operate on the tried and proven principle of the Hastings Patented Thermopile. They are fully compensated for temperature and rate of change of temperature and have rapid response. Gauge tubes are fully interchangeable without calibration adjustments. Since the response of the thermopile is electrical, the gauge tube may be located remote from the indicator.

The compact vacuum gauges are available in the following three ranges:

VT-6	0-1000 Micron Hg
VT-5	0-100 Micron Hg
VT-4	0-20 mm Hg

For more detailed information send for Specification Sheet No. 305. For full information on Hastings complete line of vacuum instruments send for Catalog No. 300.

HASTINGS-RAYDIST, Inc.
Hampton, Virginia PArk 3-6531

CIRCLE 172 ON READER-SERVICE CARD

I&CS NEW LITERATURE

CONTROL SYSTEMS AND CONTROLS

PNEUMATIC CURRENT-CONTROLLER. 2-page Data Sheet 104 describes Series EB pneumatic current controller. —Conoflow Corp., 2100 Arch St., Phila. 3, Pa.

CIRCLE 461 ON READER-SERVICE CARD

FEEDBACK CONTROL. 6-page brochure illustrates and describes operational amplifiers, frequency response test equipment, sliderules, pressure transmitters, and receivers, actuators, programmers, computers, etc.—Boonshaft and Fuchs, Inc., Hatboro Industrial Park, Hatboro, Pa.

CIRCLE 462 ON READER-SERVICE CARD

BOILER FEED CONTROL. 8-page Bulletin MSA-196 describes feedpump recirculation control from temperature differences.—Hagan Chemicals & Controls, Inc., Hagan Center, Pittsburgh 30, Pa.

CIRCLE 463 ON READER-SERVICE CARD

PROGRAM CONTROLLERS. 4-page Specification S152-7 describes line of cam-operated program controller-recorders.—Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Phila. 44, Pa.

CIRCLE 464 ON READER-SERVICE CARD

HEATING FURNACE CONTROLS. 24-page catalog Folio 122 describes industrial heating furnace control systems.—GPE Controls, Inc., 240 E. Ontario St., Chicago 11, Ill.

CIRCLE 465 ON READER-SERVICE CARD

AUTOMATIC HEATING CONTROLS. 100-page 1961-Condensed-Catalog 608 contains illustrations, descriptions, and specs of more than 240 items for controlling heating automatically.—General Controls Co., 801 Allen Ave., Glendale 1, Calif.

CIRCLE 466 ON READER-SERVICE CARD

VALVES

HIGH PRESSURE BALL VALVES. 4-page Catalog PV16-18 illustrates and describes ball valves for pressures up to 2500 psi.—Pacific Valves, Inc., 3201 Walnut Ave., Long Beach 7, Calif.

CIRCLE 467 ON READER-SERVICE CARD

BALL VALVE. 4-page brochure describes line of Econ-o-miser ball valves with center section inserted between 2 flanges.—Worcester Valve Co., Inc., 16 Parker St., Worcester, Mass.

CIRCLE 468 ON READER-SERVICE CARD

TEMPERATURE

WELLS FOR THERMOCOUPLES. 8-page catalog TT-301 covers a wide range of thermowells for the protection of thermocouples.—Trinity Equipment Corp., Cortland, N. Y.

CIRCLE 469 ON READER-SERVICE CARD

THERMOCOUPLE ASSEMBLIES. 40-page Catalog G-100-1 provides specs on special-use thermocouple assemblies and the components.—Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Phila. 44, Pa.

CIRCLE 470 ON READER-SERVICE CARD

TEMPERATURE CONTROL. 8-page booklet "The Case of the Missing Element" describes in non-technical language some basic concepts of aircraft temperature control.—Barber-Colman Co., Aircraft and Missile Products Div., Rockford, Ill.

CIRCLE 471 ON READER-SERVICE CARD

PROCESS INSTRUMENTATION. 8-page condensed Catalog 310 describes instruments systems for flow, level, pressure, temperature, and other process variables.—Fischer & Porter Co., 970 Jacksonville Rd., Warminster, Pa.

CIRCLE 472 ON READER-SERVICE CARD

BIMET-THERMOM THERMOWELLS. 6-page Catalog TT-302 provides detailed dimensional information on standard type thermowells for test instruments.—Trinity Equipment Corp., Cortland, N. Y.

CIRCLE 473 ON READER-SERVICE CARD

PRESSURE, VACUUM, ACCELERATION, STRAIN

PRESSURE TRANSMITTERS. Three specification sheets describe differential pressure transmitters, (4-page, G21-4) pneumatic pressure transmitting mechanisms (2-page P21-4) and electrical pressure transmitting mechanisms (2-page E21-4).—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

CIRCLE 474 ON READER-SERVICE CARD

PNEUMATIC RECEIVER. 2-page Product Data No. A113.1.3-10 describes Series 654 Metagraphio® Pneumatic Receiver for temperature, pressure, etc. indication.—Bristol Co., Waterbury 20, Conn.

CIRCLE 475 ON READER-SERVICE CARD

DIFF PRESS GAGE. 2-page Bulletin E10 differential pressure gage.—Pall Corp., Glen Cove, N. Y.

CIRCLE 476 ON READER-SERVICE CARD

VACUUM EVAPORATION. 4-page Catalog C-2 describes Model VE-10 automatic valving vacuum evaporator.—Mikros, Inc., Subs. of Electro Scientific Industries, 7620 S. W. Macadam Ave., Portland 19, Ore.

CIRCLE 477 ON READER-SERVICE CARD

ANGULAR ACCELEROMETER. 2-page Bulletin 116 describes transducer for measurement and control of angular acceleration.—Dynamic Measurements Co., 301 Old York Rd., Jenkintown, Pa.

CIRCLE 478 ON READER-SERVICE CARD

LABAC

VARIABLE SOLID STATE POWER REGULATOR

. . . for manual or remote control of a-c power to electrical loads.

LABAC, a lab sized a-c power regulator, replaces either a variable transformer or saturable core reactor.

COMPACT—Weighs only 7½ pounds. Takes less space than a telephone.

VERSATILE—May be adjusted manually or by remote control. Signal variation from 0 to 5 ma proportions output from zero to full power (power gain: one million). Can also be used as a silent ON-OFF controller triggered by 5-ma signal.

DURABLE—No moving parts or vacuum tubes, just a magnetic amplifier and two silicon controlled rectifiers.

CONVENIENT—Operates on 115 or 230-volt 60-cycle line, rated for 20-amp. load.

FAST RESPONSE—Within one cycle of line frequency.

APPLICATIONS—Stage light dimming • Experimental apparatus • Laboratory ovens and kilns • Sales demonstrators.

Other R-I power regulators have capacities up to 800 amps.

R-I RESEARCH INCORPORATED

Box 6164Y, Minneapolis 24, Minn

CIRCLE 173 ON READER-SERVICE CARD

LINEAR ACCELEROMETER. 2-page Bulletin 300 describes accelerometer which provides electrical output signal proportional to applied acceleration and in phase with input voltage. —Dynamic Measurements Co., 301 Old York Rd., Jenkintown, Pa.

CIRCLE 479 ON READER-SERVICE CARD

STRAIN MEASUREMENT. 20-page booklet describes "Strain Recording with Brush Direct Writing Recorders".—Brush Instruments, Div. of Clevite Corp., 37th and Perkins, Cleveland 14, Ohio.

CIRCLE 480 ON READER-SERVICE CARD

FLOW, LEVEL

ELECTRIC FLOW METERS. 2-page Specification S200-3a covers four basic models of electric instruments with pneumatic control to control liquid flow or liquid level.—Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Phila. 44, Pa.

CIRCLE 481 ON READER-SERVICE CARD

PROCESS FEEDING SYSTEMS. 8-page Bulletin 4.20-1 describes equipment for controlled feeding of liquids and solids in process industries.—B-I-F Industries, Div. New York Air Brake Co., Providence 1, R. I.

CIRCLE 482 ON READER-SERVICE CARD

LIQUID LEVEL CONTROL. 4-page bulletin describes Serv-trol automatic control to regulate pumping speed when used with magnetic drives, variable speeds motors, water rheostats and servo mechanisms.—Healy-Ruff Co., 2285 University Ave., St. Paul 14, Minn.

CIRCLE 483 ON READER-SERVICE CARD

FLOW TRANSDUCER. 4-page brochure discusses electrical pulse output type transducer.—Hydropoise, Inc., 230 S. Wells Fargo Dr., Scottsdale, Ariz.

CIRCLE 484 ON READER-SERVICE CARD

FLOW, LEVEL. 8-page Condensed Catalog illustrates and describes precision instruments for measurement of temperature, level, pressure, and flow. —Trans-Sonics, Inc., Wheeler Rd., Burlington, Mass.

CIRCLE 485 ON READER-SERVICE CARD

DISPLACEMENT, TIME, COUNT

ANGULAR DISPLACEMENT TRANSMITTER. 2-page Bulletin 200 describes transducer for translating angular position or displacement into an electrical voltage.—Dynamic Measurements Co., 301 Old York Rd., Jenkintown, Pa.

CIRCLE 486 ON READER-SERVICE CARD

LINEAR DISPLACEMENT TRANSDUCER. 2-page Bulletin 400 describes transducers for 400-cps systems.—Dynamic Measurements Co., 301 Old York Rd., Jenkintown, Pa.

CIRCLE 487 ON READER-SERVICE CARD

LINEAR DISPLACEMENT TRANSMITTER. 2-page Bulletin 100 describes transducer for translating linear position or displacement into electrical voltage.—Dynamic Measurements Co., 301 Old York Rd., Jenkintown, Pa.

CIRCLE 488 ON READER-SERVICE CARD

FACT

Flexible Automatic Circuit Tester

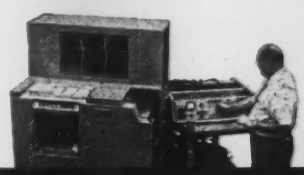
Increase the confidence level of circuit tests

Hughes has developed a high capacity, general purpose circuit tester that will substantially increase the confidence level of testing—and, at the same time, substantially reduce the costs of testing. □ Called **FACT**—short for Flexible Automatic Circuit Tester—this Hughes developed unit is self-testing and self-calibrating. Result: you increase the confidence level of the circuit test procedure. □ And with **FACT** you can eliminate the costs of developing special purpose test equipment. You can program complete tests on an unlimited number of circuits. You can substantially reduce trouble-shooting time. You can cut down programming time dramatically. (**FACT** uses standard IBM systems.) □ **FACT** is production proven and available today. With three different **FACT** models (2 card programmed and 1 tape programmed) Hughes can meet every circuit testing problem. Inquire today. Write to L. W. Risner, Hughes El Segundo, L.A. 45, California. Or, better yet, call him at ORegon 8-0361. Ext. 1652.

Creating a new world with Electronics

HUGHES

HUGHES AIRCRAFT COMPANY



CIRCLE 174 ON READER-SERVICE CARD

Phantom Pressure Surges?
Find them with Transducers & Oscillographs

by
INSTRONICS
Div. of Jani Inc.
11238 S. Western Ave.
Chicago, Ill. BE 8-3713
Phone, wire, or write for catalog #1

CIRCLE 175 ON READER-SERVICE CARD

MEASUREMENTS TO 10 MILLIONTHS
. . . read directly on a counter!
CARSON-DICE AUTOMATIC Electronic Micrometer

Accurate! The Carson-Dice Micrometer permits measurement to 10 millionths on any part or material, hard or soft, fragile or compressible.

Foolproof! Model PDR (shown) eliminates operator discrimination, measures with 0-pressure on conducting parts . . . or standard reference pressures of 1.5, 5, 10, and 20 grams on conductors or non-conductors.

FAST! Unexcelled for high-speed readings on close tolerance precision parts, semi-conductors, deposited films, grids, coated cathodes, diaphragms, wire.

Address inquiries (and submit your measurement problems) to:

J. W. DICE CO.
Englewood 10, N. J.
LOwell 9-0471

CIRCLE 176 ON READER-SERVICE CARD

ELECTRONIC INTERVAL TIMERS. 2-page bulletin describes line of electronic industrial interval timers.—Electro-Seal Corp., 938 North Ave., Des Plaines, Ill.

CIRCLE 489 ON READER-SERVICE CARD

DECADE COUNTER. 4-page Bulletin B264 describes solid state F1601 portable 12-volt decade counter.—Robotomics, Inc., 2422 E. Indian School Rd., Phoenix 16, Ariz.

CIRCLE 490 ON READER-SERVICE CARD

DATA HANDLING

DATA SYSTEM. 4-page brochure describes Model S-3100 Portable Data Gathering System.—Epsco, Inc., Systems Div., 275 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 491 ON READER-SERVICE CARD

DATA RECORDING SYSTEM. 8-page Brochure 7000 describes Series 7000 line of modular Digital Data Systems for alarm scanning and digital recording.—Monitor Systems, Inc., Subs. of Epsco, Inc., Dept. 33, Fort Washington Industrial Park, Fort Washington, Pa.

CIRCLE 492 ON READER-SERVICE CARD

DISPLAY SYSTEM. 12-page booklet describes operation and applications of Display System Model 5934 for monitoring and readout in analog computing as well as general laboratory instrumentation.—Philbrick Researches, Inc., 127 Clarendon St., Boston 16, Mass.

CIRCLE 493 ON READER-SERVICE CARD

OPTICAL ENCODERS. 8-page Catalog D contains specs and technical descriptions of Dicotron linear and sine-cosine precision optical encoders for converting angular position information into binary code.—Computer Control Co., Inc., 983 Concord St., Framingham, Mass.

CIRCLE 494 ON READER-SERVICE CARD

RECORDER/REPRODUCER. 4-page brochure describes FR-100C Instrumentation Recorder/Reproducer.—Ampex Instrumentation Products Co., Box 5001, Redwood City, Calif.

CIRCLE 495 ON READER-SERVICE CARD

MAGNETIC CORE MEMORIES. 2-page bulletin describes magnetic core memories.—Electronic Engineering Co., 1601 E. Chestnut Ave., Santa Ana, Calif.

CIRCLE 496 ON READER-SERVICE CARD

DIGITAL COMPARATOR. 2-page Bulletin DPS/A28 describes Model DK-100 digital comparator.—Datex Corp. Subs. of Gianninni Controls Corp., 1307 South Myrtle Ave., Monrovia, Calif.

CIRCLE 497 ON READER-SERVICE CARD

SCANNER. 2-page Bulletin DPS/A22 describes transistorized scanner to sequentially switch data points.—Datex Corp. Subs. of Giannini Controls Corp. 1307 South Myrtle Ave., Monrovia, Calif.

CIRCLE 498 ON READER-SERVICE CARD

DIGITAL SUBTRACTOR. 2-page Bulletin DPS/A20 describes SU-100 Series digital subtractors.—Datex Corp. Subs. of Giannini Controls Corp., 1307 South Myrtle Ave., Monrovia, Calif.

CIRCLE 499 ON READER-SERVICE CARD

SERVO REPEATER. 2-page Bulletin DPS/A23 describes SR-114 Series servo repeater for digital coded contact closures corresponding to angular position of remote shaft.—Datex Corp. Subs. of Giannini Controls Corp., 1307 South Myrtle Ave., Monrovia, Calif.

CIRCLE 500 ON READER-SERVICE CARD

TIME CODE GENERATOR. 2-page data sheet describes EECO 811 time code generator.—Electronic Engineering Co., 1601 E. Chestnut Ave., Santa Ana Calif.

CIRCLE 501 ON READER-SERVICE CARD

SHAFT ANGLE TRANSLATOR. 2-page data sheet describes EECO 780 shaft angle translator.—Electronic Engineering Co., 1601 E. Chestnut Ave., Santa Ana, Calif.

CIRCLE 502 ON READER-SERVICE CARD

DATA SYSTEM COMPONENTS. Four 2-page bulletins describe UNIDAP, a new concept of universally adaptable modular system components for data-control applications.—Data-Control Systems, Inc., East Liberty St., Danbury, Conn.

CIRCLE 503 ON READER-SERVICE CARD

ELECTRICAL, ELECTRONIC INSTRUMENTS

ELECTRICAL INDICATORS. 2-page Portable/Panel Bulletin 06-209 discusses features and specs of Model 911-912 line of a-c and d-c voltmeters and ammeters.—Davstrom, Inc., Weston Instruments Div., 614 Frelinghuysen Ave., Newark 12, N. J.

CIRCLE 504 ON READER-SERVICE CARD

ELECTRIC QUANTITY MEASUREMENT. 12-page Bulletin GEA-6788A describes full line of aircraft electrical measurement instruments.—General Electric Co., Schenectady 5, N. Y.

CIRCLE 505 ON READER-SERVICE CARD

TRUE RMS VOLTMETER. 2-page bulletin describes true rms voltmeter.—John Fluke Mfg. Co., Inc., Box 7428, Seattle 33, Wash.

CIRCLE 506 ON READER-SERVICE CARD

SEMI-DIGITAL VOLT-OHMMETER. 4-page brochure contains features, description, and specs of Type 21A semi-digital volt-ohmmeter.—J-Omega Co., 323 First St., Los Altos, Calif.

CIRCLE 507 ON READER-SERVICE CARD

LEAK DETECTORS. 8-page Bulletin GEA-6817A describes G-E's Type H line of portable, halogen sensitive, electronic leak detectors.—General Electric Co., Schenectady 5, N. Y.

CIRCLE 508 ON READER-SERVICE CARD

RECORDING

GRAPIC RECORDER. 4-page Bulletin 761 describes how inspection costs were reduced 25 to 30% through use of graphic recording instruments.—Esterline Angus Instrument Co., Inc., Box 596, Indianapolis 6, Ind.

CIRCLE 509 ON READER-SERVICE CARD

MOVING PEN RECORDERS. 4-page bulletin describes Models HR-80 and HR-87 "T-Y" recorders plotting time vs "y."—Houston Instrument Corp. Box 22234, Houston 27, Tex.

CIRCLE 510 ON READER-SERVICE CARD

RECORDERS. 8-page August, 1961 issue of "The Right Angle" describes X-Y recorder in control system analysis, magnetic-data recorder, phase-sensitive demodulator recorder, etc.—Sanborn Co., 175 Wyman St., Waltham 54, Mass.

CIRCLE 511 ON READER-SERVICE CARD

TORQUE RECORDER. 2-page Data Sheet 4403 describes automatic null-balance torque recorder.—Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., Waltham 54, Mass.

CIRCLE 512 ON READER-SERVICE CARD

RECEIVER RECORDER. 8-page Bulletin 201.11 describes Model MP-12 analogger.—Republic Flow Meters Co., Subs. of Rockwell Mfg. Co., 2240 Diversey Parkway, Chicago 47, Ill.

CIRCLE 513 ON READER-SERVICE CARD

COMMUNICATIONS

RF POWER LEVEL DETERMINATION. 12-page brochure "RF Power Bridges and Thermistor Mounts" describes these items and X-band power standards.—Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

CIRCLE 514 ON READER-SERVICE CARD

COMMUNICATION EQUIPMENT, TESTERS. 4-page Short Form Catalog illustrates and describes signal generators, monitor oscilloscopes, calibration test sets, coaxial loads, power sources, directional couplers, etc.—Sierra Electronic Corp. Div. of Philco Corp., 3885 Bohannon Dr., Menlo Park, Calif.

CIRCLE 515 ON READER-SERVICE CARD

POWER METERS. Two 2-page bulletins describe Model 450 and Model 451 microwave power meters.—General Microwave Corp., 47 Gazzo Blvd., Farmingdale, N. Y.

CIRCLE 516 ON READER-SERVICE CARD

THERMISTOR MOUNTS. 2-page bulletin describes Series 401 & 402 coaxial and waveguide thermistor mounts.—General Microwave Corp., 47 Gazza Blvd., Farmingdale, N. Y.

CIRCLE 517 ON READER-SERVICE CARD

SYNCHRO STANDARDS. 2-page brochure offers data on series of synchro standards designed to simulate the output of a master synchro transmitter.—Gertsch Products, Inc., 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

CIRCLE 518 ON READER-SERVICE CARD

MISCELLANEOUS

MAGNETOMETERS. 6-page Geophysics Technical Memorandum No. 8 discusses magnetometers used in space.—Varian Assocs., Instrument Div., Palo Alto, Calif.

CIRCLE 519 ON READER-SERVICE CARD

VOLTAGE SUPPLY. 2-page Product Sheet 102 describes constant voltage supply.—Thermo Electric Co., Inc., Saddle Brook, N. J.

CIRCLE 520 ON READER-SERVICE CARD

RESISTANCE RATIO. 4-page bulletin describes resistance standards and techniques for establishing resistance ratio accuracy to one part in ten million.—Julie Research Labs., Inc., 603 West 130th St., New York 27, N. Y.

CIRCLE 521 ON READER-SERVICE CARD

HUMIDITY INSTRUMENTATION. 8-page Catalog SF-1 covers humidity instrumentation and systems, including sensing elements, indicators, recorders, controllers, transmitters, and accessories.—Hygrodynamics, Inc., 949 Selim Rd., Silver Spring, Md.

CIRCLE 522 ON READER-SERVICE CARD

FLOW SHEET SYMBOLS. 4-page Bulletin 91-53G-02 lists symbols used in process flow sheets and schematic control systems.—Fischer & Porter Co., 946 Jacksonville Rd., Warminster, Pa.

CIRCLE 523 ON READER-SERVICE CARD

COMPRESSED AIR SYSTEMS. 4-page catalog describes drvers, hydrogenous adsorbers, and central systems for producing clean, pure, extremely low dewpoint air and other gases.—Applied Pneumatics, Inc., 740 Colfax Ave., Kenilworth, N. J.

CIRCLE 524 ON READER-SERVICE CARD

HI-TEMP WIRE. 4-page Catalog 1061 describes high-temperature insulated wire and cable for aircraft, missiles and industry.—Lewis Engineering Co., Naugatuck Conn.

CIRCLE 525 ON READER-SERVICE CARD

GAS CHROMATOGRAPHY. 2-page Data Sheet E-ND46(9) describes Speedomax G and H recorders for laboratory gas chromatography applications.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

CIRCLE 526 ON READER-SERVICE CARD

DC POWER SUPPLY. 2-page bulletin describes d-c power supply for solid-state computers.—Magnetic Research Corp., 3160 W. El Segundo Blvd., Hawthorne, Calif.

CIRCLE 527 ON READER-SERVICE CARD

PRESSURE-SENSITIVE TAPES—masking, protective, electrical, printable, etc.—are described in 44 page booklet.—Mystik Adhesive Products, Inc., 2635 No. Kildare Ave., Chicago 39, Ill.

CIRCLE 528 ON READER-SERVICE CARD

PRESSURE TRANSDUCER. 2-page Bulletin 4328 describes capabilities of Type 4-328 shunt-compensated pressure transducer.—Transducer Div., Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

CIRCLE 529 ON READER-SERVICE CARD

PRESSURE TRANSMITTERS. 2-page Bulletin R-4 describes new Compu-Tran explosion-proof, low-pressure cell for pressure measurement applications.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.

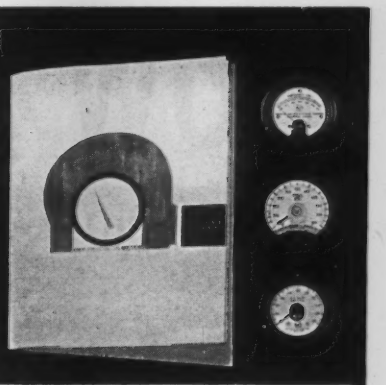
CIRCLE 530 ON READER-SERVICE CARD

PRESSURE MEASUREMENT. 4-page Bulletin describes new instrument which may be used with a high degree of accuracy as a low pressure deadweight gage or a high range differential pressure manometer. Uses "principle of operation not heretofore employed." Standard and dual scales may be read to 0.1" WC. or 0.01 psi, with full scale of 1000" WC or 36 psi.—ToPaz, Inc., 2525 South Blvd., Houston 6, Tex.

CIRCLE 531 ON READER-SERVICE CARD

GAGES. 12-page Bulletin 321.11 describes compact, easy-to-read V5 gages for indicating draft, pressure, differential gas pressure and temperature and pneumatic impulses from transmitters.—Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Ill.

CIRCLE 532 ON READER-SERVICE CARD



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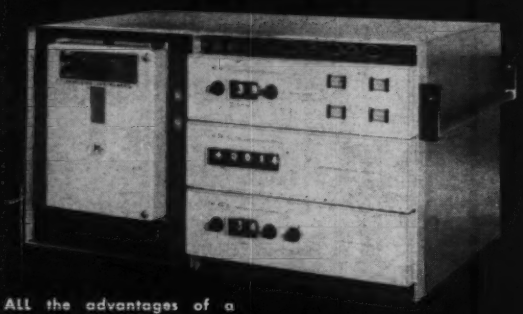

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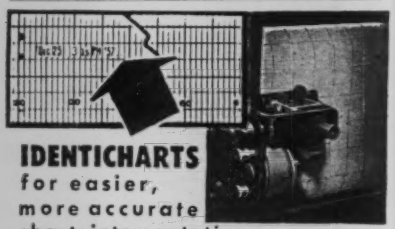

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CIRCLE 182 ON READER-SERVICE CARD

MASS SPECTROMETER. 6-page Bulletin 21130 describes Type 21-130 cycloidal focusing Mass Spectrometer utilizing cycloid tube with 1.1" focal distance and permanent magnet charged to approximately 4500 gauss. —Consolidated Electrodynamics Corp., Subs. Bell & Howell, 360 Sierra Madre Villa, Pasadena, Calif.

CIRCLE 533 ON READER-SERVICE CARD

For More INFORMATION on Products Listed Circle Number on Readers Service Card

AUTOMATIC GAGE CONTROL. 2-page Bulletin GEA-7224 describes equipment system for cold-strip steel rolling mills utilizing X-ray sensing gages and static Directo-Matic* control to keep strip on gage automatically.—General Electric Co., Schenectady 5, N. Y.

CIRCLE 535 ON READER-SERVICE CARD

DISC INDICATORS. 6-page Bulletin 4410 details disc indicators used in measuring and control systems employing resistance strain gage transducers.—Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., 42 Fourth Ave., Waltham 54, Mass.

CIRCLE 536 ON READER-SERVICE CARD

AIR DRYERS. 6-page Bulletin HA-308 details Heat-Les dynamic desiccant dryers, contains complete formulae and tables for sizing this type of dryer.—Trinity Equipment Corp., Cortland, N. Y.

CIRCLE 537 ON READER-SERVICE CARD

COMPRESSION TUBE FITTINGS. 20-page Catalog 4323 presents 25 items of Ridg-lok tube fitting line with illustrations and dimensions.—Parker Fittings & Hose Div., Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio.

CIRCLE 533 ON READER-SERVICE CARD

CR TUBES. 4-page Bulletin ET-3993 details Spiral Accelerators with 5" direct viewed flat face plate.—Sylvania, Subs. General Telephone & Electronics, 63 Second Ave., Waltham 54, Mass.

CIRCLE 539 ON READER-SERVICE CARD

RECORDING WAVE ANALYZER. 4-page brochure describes Model 800 Analyzer which displays and permanently records frequency components of any complex waveform.—Optron Corp., 335 S. Salinas St., Santa Barbara, Calif.

CIRCLE 540 ON READER-SERVICE CARD

AC LINE DRIVER. 2-page bulletin describes 863 AC Line Driver, 12-channel buffer amplifier for a-c signals over frequency range from 100 to 20,000 cps.—Electronic Engineering Co. of Calif., 1601 E. Chestnut Ave., Santa Ana, Calif.

CIRCLE 541 ON READER-SERVICE CARD

TELEMETERING. 2-page Bulletin 7110 details Digital Recording System for measurement of voltage, demand, wattage, etc. at remote electric utility sub-stations and telemetering of information in digital form to central recording station.—Monitor Systems, Inc., Subs. Epsco, Inc., Dept. 31, Fort Washington Industrial Park, Fort Washington, Pa.

CIRCLE 542 ON READER-SERVICE CARD

PNEUMATIC TOTALIZER. 2-page Spec Sheet 282-09.201-1 describes with dimensional sketch self contained panel mounted Pneumatic Totalizer Model 282-09.—B-I-F Industries, Box 276, Providence, R. I.

CIRCLE 543 ON READER-SERVICE CARD

STREAM BLENDING SYSTEMS. 4-page Bulletin 2000.20-1 details many of the advantages and improved techniques of blending, both for refining and pipelining as well as marketing.—B-I-F Industries, Box 276, Providence, R. I.

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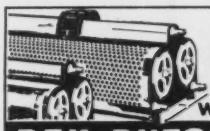

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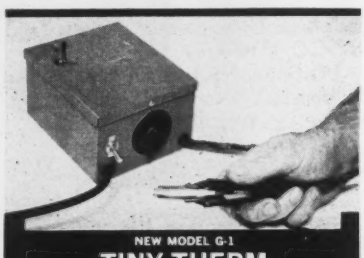

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CIRCLE 186 ON READER-SERVICE CARD

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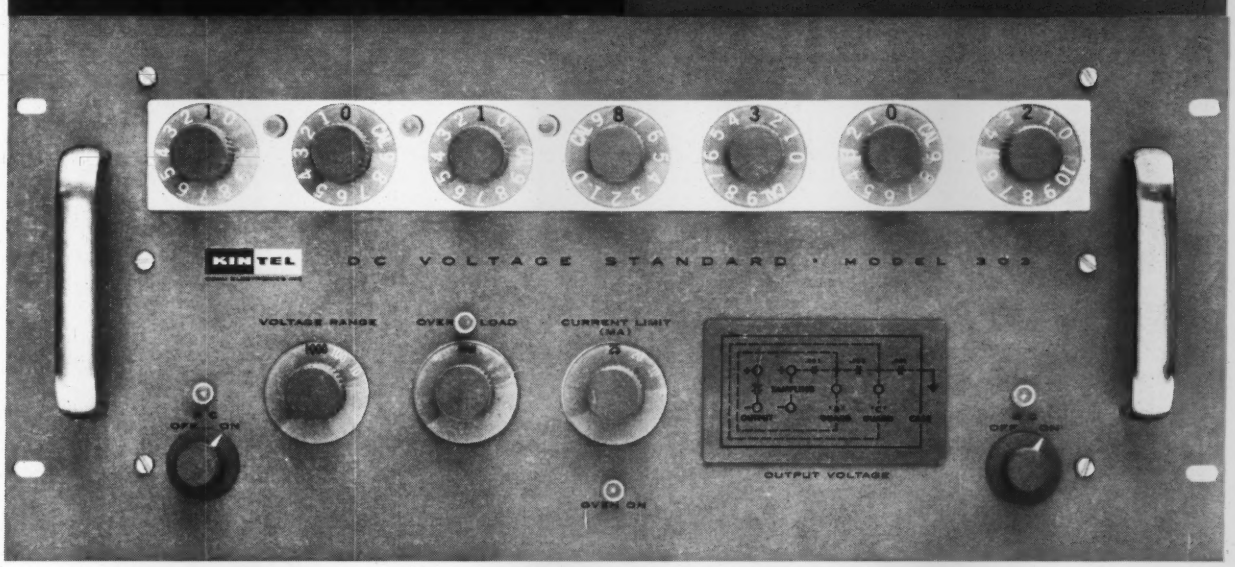

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The voltage is held stable within 0.0025% of the dialed output for over eight hours, within 0.005% for over 30 days. Absolute accuracy is better than 0.01% of the setting.

The 303 has a four-terminal output–two to furnish current for the load, and two to sample the voltage across the load. By sampling at the load, no error is caused by current flowing through external leads, and the effective source impedance *at the load* is 0.001 ohm. Full accuracy is maintained with lead lengths on the order of 10 feet.

The output circuit is completely floating, shielded, and guarded – isolated from both chassis and power-line ground. Common-mode intermodulation products are rejected by 120 db at 60 cps.

Output current may be limited by a panel control to 5, 10, 15, or 25 milliamperes. An overload relay disconnects the output terminals if the selected current is exceeded or if the output voltage deviates from the setting.

These features make the 303 an ideal standard. Its wide range and high accuracy make it useful in many laboratory and industrial applications. And its exceptional resolution makes it especially valuable when small increments of voltage are needed. Price $2800.

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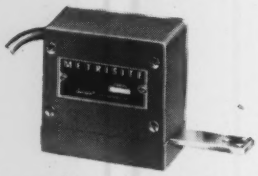
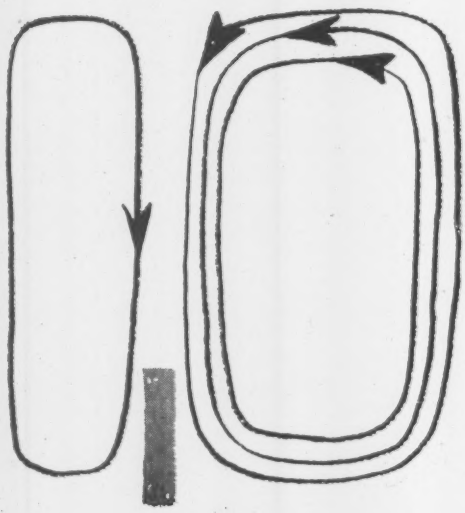
Metrisite...is the only device available today that provides a near-perfect combination of ideal transducer characteristics. The unusual properties of this remarkable new motion-sensing development are: extreme resolution...  easily measures one ten-millionth of an inch; minute operating force...absolute minimum bearing friction; negligible reactive force... a fraction of a milligram; true linearity...a proven accuracy of 1/10%; high electrical output...up to 100 volts without amplification; wide range of shapes and sizes...from sub-miniature on up; exceptional ruggedness...can meet military shock and vibration tests. Now, many of the obstacles that have plagued control technology can be eliminated. Write for Metrisite details.



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